GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: May 18, 1977

Project Title: TRIP-77 (Thunderstorm Research International Project)

Project No: A-1995

Project Director: Mr. C. S. Wilson

Sponsor: NASA-Goddard Space Flight Center

Agreement Period: From 5/4/77 Until ~~5/4/78~~ 6/4/80 (Contract Period)

Type Agreement: Contract No. NAS5-24148

Amount: $14,997

Reports Required: Quarterly Progress Reports, Final Project Report.

Sponsor Contact Person (s):

Technical Matters

D. M. LeVine, Code 953
Technical Officer
NASA-Goddard Space Flight Ctr.
Greenbelt Road
Greenbelt, Maryland 20771

Contractual Matters
(thru OCA)

Office of Naval Research
Resident Representative
325 Hinman Research Building
Georgia Institute of Technology
Atlanta, Georgia 30332

Defense Priority Rating: N/A

Assigned to: Electronics Technology Laboratory (School/Laboratory)

COPIES TO:

- Project Director
- Division Chief (EES)
- School/Laboratory Director
- Dean/Director—EES
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- Library, Technical Reports Section
- Office of Computing Services
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- EES Information Office
- Project File (OCA)
- Project Code (GTRI)
- Other

A-3 (3/76)

B-33-294

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 7/30/81

Project Title: TRIP-77 Thunderstorm Research International Project

Project No: A-1995

Project Director: B. J. Wilson

Sponsor: NASA Goddard Space Flight Center

Effective Termination Date: 6/4/81

Clearance of Accounting Charges: 6/10/81

Grant/Contract Closeout Actions Remaining:

- x Final Invoice and Closing Documents
- _ Final Fiscal Report
- x Final Report of Inventions
- x Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other _____

Assigned to: ECSL/CSD (School/Laboratory)

COPIES TO:

Administrative Coordinator
Research Property Management
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Project File (OCA)
Other: _____

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 2, 1977

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 953

Subject: Quarterly Progress Report No. 1
Contract NAS5-24148

Gentlemen:

During this first quarter of the referenced contract the major project emphasis has been directed to (1) modifications and additions to the severe weather instrumentation package developed under Contract NAS5-20956 and (2) participation in the Thunderstorm Research International Project (TRIP) that was conducted at the Kennedy Space Center, Florida.

The equipment modifications consisted primarily of the addition of an event marker and the design and fabrication of a lightning counter. The purpose of the event marker is to allow a remote observer to accurately mark the occurrence of a cloud-to-ground stroke; the event being recorded as a short burst ($\sim$ 0.5 sec) of sinusoidal signal that is fed to a selected channel of the instrumentation tape recorder. The purpose of the lightning counter is to compile the total number of lightning events within a one-minute time period and then to output the accumulated number in the form of a front panel digital readout and in a signal-coded format suitable for recording on a selected channel of the instrumentation tape recorder.

The equipment modifications and additions were completed during the first part of this quarter as required and prior to the start of the field operations at the Kennedy Space Center.

During the later portion of this quarter the project efforts were directed to the field operations at the Kennedy Space Center. This field operation began on 5 July 1977 and will terminate on or about 2 August 1977. During this time period, sferics data will be collected on the convective type thunderstorms which are generally a regular occurrence during the summer months in mid-Florida.

During the coming quarter the major project efforts will be directed to compiling the data logs that resulted from the field operation and to discussions with NASA personnel regarding the results of this field experiment program.

Respectfully submitted,

Charles S. Wilson,
Project Director

CSW:am

Approved:

_____

D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 1 for the period: 4 May 1977 to 31 July 1977
Contract NAS5-24148

BUDGET PLANS OF EXPENDITURE BY QUARTER

Second Quarter,	8/1/77 - 10/31/77	$2190
Third Quarter,	11/1/77 - 1/31/78	1250
Fourth Quarter,	2/1/78 - 4/30/78	2827
		$6267

CURRENT QUARTER ACTUAL COSTS:

$8730

CUMULATIVE TOTAL COST TO DATE:

$8730

ESTIMATE TO COMPLETE:

$6267

A-1495

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 30, 1977

National Aeronautics and Space
Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 953

Subject: Quarterly Progress Report No. 2
Contract NAS5-24148

Gentlemen:

During the second quarter of the subject contract the project efforts were directed to (1) the final phase of our participation in the Thunderstorm Research International Project (TRIP) at the Kennedy Space Center, Florida and (2) the compilation and documentation of the data that were obtained during the field operation. This field operation at KSC was begun during the first quarter of the project.

During the course of the KSC field operation a total of 33 reels of magnetically recorded data tapes were obtained. The majority of the data resulted from thunderstorm activity that occurred between 22 July and 1 August. During the early portion of the field operation, specifically between 5 July and 22 July, there was an unusually small incidence of thunderstorms for this portion of Florida. As a result, the time period was spent primarily in performing system tests and evaluation.

The later part of July brought a significant increase in the amount of thunderstorm activity and as a result a large amount of sferics data were obtained during this period. The majority of thunderstorm activity was of the convective type that is common in Florida during the summer months. However, on the afternoon of 1 August a tornado did develop during heavy thunderstorm activity and touched down briefly near a mobile home park in Mims, Florida, but caused no damage. The funnel cloud was visible from the field site at KSC and sferics data were being acquired during this period.

A data log of the field operations at the Kennedy Space Center has been prepared in final form for submission to NASA in accordance with Article II, Item 2 of the subject contract. This data log and the 33 reels of magnetic tape are being prepared for shipment to NASA with actual shipment to occur within the next several days.

During the coming quarter the major project efforts will be directed to continued discussions with NASA personnel regarding the results of the field operations and of potential improvements and modification to the sferics data collection process.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW:lb

Approved:

D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 2 for the period 1 August 1977 to 31 October 1977
Contract NAS5-24148

BUDGET PLANS OF EXPENDITURE BY QUARTER:

Third quarter, 11/1/77 - 1/31/78	$1200
Fourth quarter, 2/1/78 - 4/30/78	2612
	$3812

CURRENT QUARTER ACTUAL COSTS:

$4018

CUMULATIVE TOTAL COST TO DATE:

$11,186

ESTIMATE TO COMPLETE:

$3812

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

February 8, 1978

National Aeronautics and Space
Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 953

Subject: Quarterly Progress Report No. 3
Contract NAS5-24148

Gentlemen:

During the third quarter of the subject contract period the project efforts have been directed to (1) discussions with NASA personnel regarding the results of the field operation and of the data obtained during the Thunderstorm Research International Project (TRIP), and (2) formulation of requirements and plans for the 1978 TRIP field experiment.

During the early part of this quarter a data log describing the field operations at the Kennedy Space Center (TRIP-77) and 33 reels of data tapes were submitted to NASA in accordance with Article II, Item 2 of the subject contract. This Ground-Based Field Operation Data Log provides a comprehensive documentation of the day-to-day activities of the field operation including (1) meteorological conditions, (2) continuous update of instrumentation settings and operating conditions, (3) tape recorder channel assignments, and (4) visual and aural observation as provided by other, co-located investigators.

The 33 reels of magnetic tape represent the total of the recorded data that were acquired during the course of the field operation. Because of the unusual weather pattern at the Kennedy Space Center this past July, i.e., almost zero thunderstorm activity during the first part of the month, 80 percent of the data were acquired during the last ten (10) days of the field operation.

During the fourth quarter of this contract the major effort will be directed to the preparation of a final project report. The final report will provide a documentation of the project goals, activities, and results. The report will include: (1) a summary of the overall project objectives and general activities, (2) a documentation of the severe weather instrumentation system with emphasis on the system modifications and additions that were accomplished this past year, (3) a general outline and summary

of the 1977 field operation at the Kennedy Space Center (TRIP-77), and (4) recommendations regarding future severe weather monitoring activities.

Respectfully submitted,

Charles S. Wilson
Project Director

Approved:

D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 3 for the period: 1 November 1977 to 31 January 1978
Contract NAS5-24148

BUDGET PLANS OF EXPENDITURE BY QUARTER:

Fourth Quarter, 2/1/78 - 4/30/78 $3347

CURRENT QUARTER ACTUAL COSTS:

$465

CUMULATIVE TOTAL COST TO DATE:

$11,650

ESTIMATE TO COMPLETE:

$3347

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 15, 1978

National Aeronautics and Space
Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attntion: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 953

Subject: Quarterly Progress Report No. 4
Contract NAS5-24148

Gentlemen:

During the fourth quarter of the subject contract period, project efforts have been directed primarily to preparation of the Final Project Report. In addition to this effort, discussions have been conducted with NASA personnel in a recent visit to GSFC regarding both past and future efforts in severe storm research.

A draft copy of the Final Project Report is essentially ready for submission. The report documents both the field operations which were conducted at the Kennedy Space Center during TRIP-77, and the additions and modifications made to the severe weather data acquisition system prior to start of these field operations. The final report also documents, chronologically, the progressive development of the instrumentation system since its inception in 1975 and briefly describes activities surrounding the numerous field operations where the instrumentation has been used. Following approval by NASA of the draft report, a final report will be submitted in accordance with contract requirements.

Respectively submitted,

Charles S. Wilson
Project Director

CSW:lsl

Approved:

D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 4 for the period: 1 February 1978 to 30 April 1978
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$1678

CUMULATIVE TOTAL COST TO DATE:

$13,398

ESTIMATE TO COMPLETE:

$1599

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 31, 1978

National Aeronautics and Space
Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. More, Code 289
Dr. D. M. LeVine, Code 953

Subject: Quarterly Progress Report No. 5
Contract NAS5-24148

Gentlemen:

During this fifth quarter of the subject contract period, project efforts have been directed primarily to preparation of a final draft report and to participation in a two-week field operation at the Kennedy Space Center, Florida during the Thunderstorm Research International Program (TRIP-78).

During the first part of this quarter a final technical summary report, entitled TRIP-77 (Thunderstorm Research International Project), was prepared and submitted in draft form to NASA for approval. This report consists of several sections providing (1) a historical background which summarizes the instrumentation development and various field operations, (2) a description of modifications and additions made to the instrumentation system during the current contract period, and (3) a summary of activities which occurred during the 1977 field operations at the Kennedy Space Center, Florida.

This draft copy of the final technical report was submitted to NASA/GSFC during the first week of June 1978. After approval by cognizant NASA personnel, final copies of the report will be submitted in accordance with contract requirements.

A major portion of the project effort during this quarter was devoted to preparation for, and participation in, a two-week field operation during TRIP-78 at the Kennedy Space Center, Florida. Preparation was primarily directed to test and check-out of the existing severe weather instrumentation system. No additions or modifications were made to the instrumentation system this year. During the two-week field operation a large amount of sferics data was acquired; the majority of data being acquired from the low frequency, E-field receiver rather than the HF and VHF receivers as has been the case in previous field operations. This E-field data was initially stored in a Biomation Model 8100 transient recorder, then outputted to an x-y plotter. The majority of data was recorded in this manner rather than on magnetic tape as has been the practice previously. A large number of x-y plots of sferic waveforms were compiled during the experiment period.

During the coming quarter a brief summary of the 1978 field operation will be prepared and submitted in accordance with contract requirements. The summary is in preparation at the present time.

Respectfully submitted,

Charles S. Wilson
Project Director

Approval:

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D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 5 for the period: 1 May 1978 to 31 July 1978
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$4550

CUMULATIVE TOTAL COST TO DATE:

$19,590

ESTIMATE TO COMPLETE:

$403

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 14, 1978

National Aeronautics and Space
Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 6
Contract NAS5-24148

Gentlemen:

During this reporting period the major project efforts were directed to preparation of a data log which describes and summarizes the July field operations at the Kennedy Space Center, Florida during TRIP-78. This data log has been organized in such a manner as to provide cognizant NASA personnel with a ready reference to the field operation at Kennedy Space Center, and consists of several sections which provide not only a written record of specific data obtained during the course of the field operation but also provides other pertinent information such as tape recorder channel assignments and the manner in which elements of the instrumentation were interconnected for various experiments. The log is especially intended for use in conjunction with the numerous X-Y data plots and magnetic recordings which were acquired during the course of the field operation and which were submitted earlier to the NASA technical monitor. The data log was submitted to NASA in mid-October.

A draft copy of the final technical report was submitted to NASA for approval in June 1978. During this reporting period, NASA approval was given for preparation of final copies of the report. Based on this approval, final copies will be prepared and submitted in accordance with contract requirements.

Respectfully submitted,

Charles S. Wilson
Project Director

APPROVED

D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 6 for the period: 1 July 1978 to 31 October 1978
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$4877

CUMULATIVE TOTAL COST TO DATE:

$14,937

ESTIMATE TO COMPLETE:

$60

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

February 20, 1979

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 7
Contract NAS5-24148

Gentlemen:

The project efforts during this reporting period were primarly directed to an evaluation of the procedures and results of the field experiment conducted at the Kennedy Space Center during TRIP-78. This evaluation has been limited to discussions with the technical monitor. The discussions have also been directed to future plans; specifically to needed changes in the data acquisition system, improved operating procedures, and to effective methods for data reduction.

During the coming quarterly period the project efforts will be directed to submission of the final technical report. Approval of the draft by cognizant NASA personnel has been obtained; thus, final copies will be prepared and submitted in accordance with contract requirements.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW:lsl

CONTRACTOR COST CORRELATION DATA:

Report 7 for the period: 1 November 1978 to 31 January 1979
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

-0-

CUMULATIVE TOTAL COST TO DATE:

$14,937

ESTIMATE TO COMPLETE:

$60

A-1995

GTEES ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 4, 1979

National Aeronautics and Space
Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 8
Contract NAS5-24148

Gentlemen:

The project efforts during this reporting period have been primarily directed to an evaluation of the existing severe weather instrumentation system, field operating procedures, and methods for improving overall operation. Discussions have been conducted with the technical monitor regarding these matters and some ideas and plans have been formulated as a result. These discussions are a result of a need to improve the data collection capability and the need for more comprehensive data collection efforts leading to an increased capability for severe storm prediction.

At present, plans are being formulated for future efforts. Also, during the current month, final copies of the technical report will be submitted in accordance with contract requirements.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW/lb

Approved

D. W. Robertson, Director
Electronics Technology Laboratory

CONTRACTOR COST CORRELATION DATA:

Report 8 for the period: 1 February 1979 to 30 April 1979
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

-0-

CUMULATIVE TOTAL COST TO DATE:

$14,937

ESTIMATE TO COMPLETE:

$60

A-1111-

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

2 October 1979

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 9
Contract NAS5-24148
Project A-1995

Gentlemen:

During this quarterly reporting period, covering 5 June through 31 August 1979, the major project emphasis has been directed to (1) additions and modifications to the severe weather instrumentation package developed under Contract NAS5-20956 and (2) participating in data collecting field operations at Socorro, NM (TRIP-79) and at NASA/Wallops Flight Center, VA.

The general nature of the field operations were to:

1. Install and maintain equipment, provide a research vehicle to house the electronics, and provide miscellaneous support electronics equipment (e.g., dual channel oscilloscope, scope camera, two channel brush recorder and x-y plotter).

2. Operate the equipment for a period of 8 weeks (original schedule) with the first two weeks to be at Socorro, NM; the remaining period at NASA/Wallops Flight Center, VA.

3. Maintain a log of observations and operations during the experiment.

The broad objective of these field operations has been to study RF radiation from lightning to determine the potential of applying these RF techniques to aid in the monitoring of severe storms. A long-term goal is development of an ability to utilize this RF monitoring capability from space satellites.

Prior to start of the current year's field operations, a number of additions and modifications were made to the existing instrumentation package. The nature of the instrumentation changes were:

1. Antennas: Providing a new antenna system for the RF lightning detection system with a capability of being mounted away from the research vehicle and having known receiving cross-section.

2. Trigger System: Providing a trigger system for generation of a pulse suitable to trigger other devices when the RF input signal exceeded an adjustable threshold.

3. Time Code Generator: Modification of the time code generator output signal to include a parallel slow time code suitable for recording on a strip chart.

4. Event Marker: Provision of an event marker for the strip chart recorder with triggering from (2) above.

The instrumentation changes were completed prior to start of the field operations. However, during the course of the field operations, additional changes and modifications were made. In some cases these field modifications resulted in minor additional changes to those listed above; whereas, in other cases, modifications and additions were performed on older portions of the instrumentation system to provide a needed capability for the current field operation. An example is development of special purpose circuitry to minimize 60 Hertz pickup encountered on the E field antenna system.

Considerable and varied activity occurred during the course of the field operations. This activity encompassed not only the primary task of data collection but also involved instrumentation changes (as briefly mentioned above) and interaction and coordination with other participants in these field experiments. A short discussion of field related events follows.

Field operations for TRIP-79 consisted of two weeks of data collection in Socorro, NM. The test site was located in the vicinity of the Irving Langmuir Laboratory located near South Baldy Peak in the Magdalena Mountains of the Cibola National Forest.

During the period from 9 July 1979 to 20 July 1979 very little data was obtained. The first week of the experiment consisted of installing and calibrating the instrumentation at the field site. During the second week some thunder storms did occur, and a small amount of data were collected and documented.

At the conclusion of the experiment in Socorro, NM, the instrumentation was relocated to a test site at Wallops Island, VA for participation in the Storm Hazard '79 Program conducted by the NASA/Langley Research Center. The instrumentation was installed in a Georgia Tech-owned van which was located near the SPANDAR facility on Wallops Island.

During the period from 23 July 1979 to 9 September 1979, a total of eight thunderstorm days occurred in which a total of twenty-four data tapes were collected. Twenty-two of the data tapes were collected independently of the Storm Hazard '79 Program in order to obtain a broader data base. Two data tapes were obtained in conjunction with airborne flights conducted by NASA Langley Research Center.

During the coming quarter the project efforts will be directed primarily to preparation and submission of the data logs. In addition, some efforts will be expended in an analysis, test, and evaluation of the instrumentation system as it currently exists. Needed modifications, changes, and improvements were identified during the course of these just-concluded field operations. As a result of this identification, we will investigate methods and techniques for implementing needed improvements. The extent of this investigation will be determined by the funds available after the data logs have been submitted.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW:gh

Approved:

R. W. Moss, Head
Communications Systems Branch

CONTRACTOR COST CORRELATION DATA:

Report 9 for the period: 5 June 1979 to 31 August 1979
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$18,087

CUMULATIVE TOTAL COST TO DATE:

$40,802

ESTIMATE TO COMPLETE:

$9,121

Note: The field operations were extended into the present quarterly time period; thus a portion of the available funding listed under ESTIMATE TO COMPLETE will be applied to the total field operation costs.

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Attention: Mr. D. D. Moore, Code 289
Mr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 10
Contract NAS5-24148
Project A-1995

Gentlemen:

During this quarterly period, covering 1 September to 30 November 1979, project emphasis have been directed to preparation of the data logs resulting from the extensive field operation at Wallops Island, Virginia.

This log will provide a thorough and comprehensive summary of data obtained during the course of the field operation, which, along with the associated magnetic tape recordings and strip chart recordings, should provide a firm data base for further storm analysis. At present, the data log is essentially finished and following an additional review for accuracy and completeness will be formally submitted in accordance with contract requirements.

During the coming quarter, project emphasis will be directed primarily to informal evaluation of the recent field operations and, where possible under the limited funds still available, test and evaluation of the sferics monitoring instrumentation system. These tests and evaluation will be primarily for the purpose of identifying needed system improvements.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW:ll

APPROVED:

R. W. Moss, Head
Communications Systems Branch

CONTRACTOR COST CORRELATION DATA:

Report 10 for the period: 1 September to 30 November 1979
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$7,318

CUMULATIVE TOTAL COST TO DATE:

$48,119

ESTIMATE TO COMPLETE:

$1,804

A-1995

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

March 17, 1980

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Md. 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 11
Contract NAS5-24148
Project A-1995

Gentlemen:

During this quarterly reporting period, covering 1 December 1979 to 29 February 1980, project emphasis has been directed to submission of the data log and to general evaluation and planning efforts regarding the sferics instrumentation system, field operations, and data acquisition techniques.

The data log describing field operations at Socorro, NM and at Wallops Island, Va. were submitted during the first part of this quarter. The logs provided a thorough and comprehensive summary of data obtained during the course of these field operations, data which will be of value to both GSFC and Langley Research Center in their study and analysis of lightning and its effects on aircraft design and operations.

During the coming quarter project efforts will be directed to an informal evaluation of the past year's operations and to planning for future efforts. All requirements for the present effort have been fulfilled.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW/pf

APPROVED:

R. W. Moss, Chief
Communications System Division

CONTRACTOR COST CORRELATION DATA:

Report 11 for the period: 1 December 1979 to 29 February 1980
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$1,804

CUMULATIVE TOTAL COST TO DATE:

$49,923

ESTIMATE TO COMPLETE:

$0

#-1995

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

June 25, 1980

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Md. 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 12
Contract NAS5-24148
Project A-1995

Gentlemen:

During this quarterly reporting period, covering 1 March to 30 May 1980, project efforts have been directed primarily to preparation for the 1980 field operations at Wallops Island, Virginia.

The major emphasis of the field preparation efforts are being directed to design and fabrication of lightning monitoring instrumentation for permanent installation at the Spandar facility, NASA/WFC. In addition, modifications are being made to all video processors for assuring the desired frequency response characteristics. New and enhanced E and H field capabilities are also being added to the system. This E and H field capability includes a three-level, slow E function for increasing the effective dynamic range and an H field capability consisting of a crossed-loop antenna and associated amplifiers.

During the coming quarter, project efforts will be directed principally to the field operation at NASA/WFC. In conjunction with this field operation, a data log will be maintained and submitted to NASA/GSFC at the conclusion of the field experiment period.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW/pf

APPROVED:

R. W. Moss, Chief
Communications System Division

CONTRACTOR COST CORRELATION DATA:

Report 12 for the period: 1 March to 30 May 1980
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$7,460

CUMULATIVE TOTAL COST TO DATE:

$59,955

ESTIMATE TO COMPLETE:

$21,830

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

4 September 1980

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 13
Contract NAS5-24148
Project A-1995

Gentlemen:

Project efforts during this quarterly period covering 1 June to 31 August have been primarily directed to field experiments at Wallops Island, Virginia.

During the period of 20 June to 2 July the 1980 field experiments were begun at WFC. The first part of the period was devoted to equipment installation and checkout at the SPANDAR facility, Wallops Island. Following installation and checkout data was acquired on some thunderstorm activity.

Additional field activities occurred during the period of 12-31 July. The primary effort during this period was devoted to data collection efforts in support of airborne, severe weather experiments conducted by NASA/Langley. Data was acquired on several storms during this period with the results being contained on magnetic tape, with supporting documentation being in the form of satellite and radar photos.

Further field operations were begun on 11 August and are scheduled to continue into the early part of September. This period will be the concluding part of the 1980 field experiments.

A data log of operations has been maintained during the data collection efforts. Following the field operations period the data log

will be finalized and prepared for submission to NASA/GSFC in accordance with contract requirements.

Respectfully submitted,

Charles S. Wilson
Project Director

CSW/kr

APPROVED:

_____

R. W. Moss, Chief
Communications System Division

CONTRACTOR COST CORRELATION DATA:

Report 13 for the period: 1 June 1980 to 31 August 1980
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$23,564

CUMULATIVE TOTAL COST TO DATE:

$81,748

ESTIMATE TO COMPLETE:

$2,967

A-1995

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

December 2, 1980

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Md. 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 14
Contract NAS5-24148
Project A-1995

Gentlemen:

Project efforts during this quarterly period covering 1 September to 30 November have been primarily directed to completing the field experiments at Wallops Island, Virginia and preparing the final Data Log on the results of the 1980 Storm Hazards Program.

The final data log was completed during this reporting period and submitted to NASA/GSFC in accordance with contract requirements.

At the conclusion of the 1980 field experiment a lightning detection system was installed at the SPANDAR facility at Wallops Island, Virginia. This system included an RF receiver (WJ-8733), Slow and Fast electric field unit, 60Hz phase shifter and associated antenna system.

During the coming quarter, project efforts will be directed to completing the operation and instruction manual and evaluating the past year's efforts.

Respectfully submitted,

Bobby J. Wilson
Project Director

BJW/pf

APPROVED:

R. W. Moss, Chief
Communications System Division

CONTRACTOR COST CORRELATION DATA:

Report 14 for the period: 1 September 1980 to 30 November 1980
Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$2,934

CUMULATIVE TOTAL COST TO DATE:

$84,682

ESTIMATE TO COMPLETE:

$33

A-1995

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

March 3, 1981

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Subject: Quarterly Progress Report No. 15
Contract NAS5-24148
Project A-1995

Gentlemen:

During this quarterly period, covering 1 December to 28 February 1981, project emphasis have been directed to preparation of the operations and instruction manual.

This instruction and operations manual will consist of a brief description of the operation of the sferics monitoring equipment. At present, the manual is approximately 90 percent complete and following an additional review for accuracy and completeness will be formally submitted in accordance with contract requirement.

During the coming quarter, project emphasis will be directed primarily to completing the operations manual and, where possible under limited funds, evaluate the past year's operations and to plan for future effort.

Respectfully submitted,

Bobby J. Wilson
Project Director

APPROVED:

R. W. Moss, Chief
Communications Systems Division

BJW:ae

CONTRACTOR COST CORRELATION DATA:

Report 15 for the period: 1 December 1980 to 28 February 1981

Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$33.00

CUMULATIVE TOTAL COST TO DATE:

$87,616

ESTIMATED TO COMPLETE:

$0

LIBRARY DOES NOT HAVE Quarterly Progress Report #16.

A-1995

Georgia Institute of Technology

ENGINEERING EXPERIMENT STATION

ATLANTA, GEORGIA 30332

26 May 1981

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Attention: Mr. D. D. Moore, Code 289
Dr. D. M. LeVine, Code 946

Reference: Contract No. NAS5-24148
"Studying RF Radiation from Lightning to Determine the Potential of Applying RF Techniques to Aid in the Monitoring of Severe Storms"
Georgia Tech Project A-1995

Subject: Quarterly Progress Report No. 17
1 March through 31 May 1981

Gentlemen:

During this quarterly period project emphasis has been directed to completing the operation and instruction manual.

The operation and instruction manual is in final form and will be submitted as scheduled. All requirements for the present effort have been fulfuilled.

Respectfully submitted,

Bobby J. Wilson
Project Director

BJW:gh

APPROVED:

R. W. Moss, Chief
Communications Systems Division

CONTRACTOR COST CORRELATION DATA:

Report 17 for the period: 1 March 1981 to 31 May 1981

Contract NAS5-24148

CURRENT QUARTER ACTUAL COSTS:

$68.00

CUMULATIVE TOTAL COST TO DATE:

$84,715

ESTIMATED TO COMPLETE:

$0

GROUND-BASED FIELD OPERATION DATA LOG

THUNDERSTORM RESEARCH INTERNATIONAL PROJECT
TRIP-77
KENNEDY SPACE CENTER, FLORIDA

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

12 July - 1 August 1977

Contract NAS5-24148

By

C. S. Wilson and B. J. Wilson

FOREWORD

This document was prepared by the Engineering Experiment Station at Georgia Tech under Contract NAS5-24148. The data gathering and documentation effort was performed by personnel of the Electronics Technology Laboratory, Communications Technology Group, and was conducted under the general supervision of Mr. D. W. Robertson, Laboratory Director, and Mr. R. W. Moss, Group Head. Mr. C. S. Wilson was Project Director. This document presents a general description and the observer's summary of the ground-based field experiment conducted at the Kennedy Space Center, Florida during July and August 1977. The information contained in this document, in conjunction with the associated magnetic tape recordings of the sferic signals, provides the data information specified in Article II, Item 2 of the subject contract.

The assistance and data contributions of Dr. E. Philip Krider of the University of Arizona is gratefully acknowledged as is the overall guidance of Dr. D. M. LeVine of NASA.

INTRODUCTION

This document presents a summary of the visual and aural observations associated with the Kennedy Space Center, Florida ground-based experiments that were conducted between 12 July and 1 August 1977. All data were obtained with the Georgia Tech van located at camera site UCS-12.

This document consists of the following sections:

- Summary of Data Tapes which provides a listing of all the magnetic recording tapes and the date, time, tape speed and abbreviated comments associated with each tape.

- Tape Recorder Channel Assignments which lists the input signal source, the manner in which the signal was recorded (FM or direct), and the assigned channel of the Ampex PR 2200 tape recorder.

- Visual/Aural Data Log which provides detailed and specific information regarding the observer's comments, equipment settings and times for each of the 33 tapes covered by this document.

SUMMARY OF DATA TAPES

TAPE NUMBER	DATE	ZULU TIME		TAPE SPEED	GIT SFERICS DATA	COMMENTS
		START	STOP			
1	12 July	193:21:50:00	193:22:12:00	30	No	No visual data.
2	15 July	196:20:56:55	196:21:20:14	30	No	No visual data.
3	18 July	199:19:02:50	199:19:18:26	60	No	No visual data, this tape has time interruption.
4	22 July	203:17:30:51	203:17:54:43	30	Yes	S-Band data being collected by Dave Rust. No visual data.
5	22 July	203:18:09:13	203:18;33:13	30	Yes	S-Band data being collected by Dave Rust. No visual data.
6	22 July	203:18:50:00	203:19:14:52	30	Yes	U. of A. visual log, no GIT visual data.
7	23 July	204:14:50:02	204:15:12:00	60	Yes	No visual data. This tape has time interruption.
8	23 July	204:15:18:30	204:15:30:45	60	Yes	No visual data.
9	23 July	204:17:06:00	204:17:18:02	60	Yes	No visual data.
10	23 July	204:19:57:32	204:20:40:27	60	Yes	No visual data. This tape has time interruption.
11	23 July	204:20:47:50	204:21:04:06	60	Yes	No visual data. This tape has time interruption.
12	27 July	208:19:58:01	208:20:21:58	30	Yes	No visual data.
13	27 July	208:21:04:50	208:21:33:19	30	Yes	No visual data.
14	28 July	209:18:46:45	209:18:58:53	60	Yes	Time correlated visual data.

TAPE NUMBER	DATE	ZULU TIME START	ZULU TIME STOP	TAPE SPEED	GIT SFERICS DATA	COMMENTS
15	28 July	209:19:02:05	209:19:14:12	60	Yes	U. of A. visual data, no GIT visual data.
16	28 July	209:19:16:56	209:19:41:04	30	Yes	U. of A. visual data, no GIT visual data.
17	28 July	209:19:44:21	209:19:56:24	60	Yes	U. of A. visual data, no GIT visual data.
18	28 July	209:20:00:52	209:20:13:34	60	Yes	U. of A. visual data, no GIT visual data.
19	28 July	209:20:19:05	209:20:31:08	60	Yes	GIT time correlated visual data. U. of A. visual data.
20	28 July	209:20:34:25	209:20:46:33	60	Yes	GIT time correlated visual data. U. of A. visual data.
21	28 July	209:20:59:23	209:21:23:28	30	Yes	U. of A. visual data, no GIT visual data.
22	28 July	209:21:28:30	209:21:40:34	60	Yes	U. Of A. visual data, no GIT visual data.
23	30 July	211:19:34:09	211:19:58:30	30	No	U. of A. visual data, no GIT visual data.
24	30 July	211:19:59:55	211:20:04:22	30	No	Lost power on this tape.
24A	30 July	212:01:24:56	212:01:46:09	30	No	U. of A. visual data. This is a restart of Tape # 24, no GIT visual data.
25	30 July	212:01:48:37	212:02:01:07	60	No	No GIT visual data, U. of A. visual data.
26	31 July	212:18:39:15	212:19:04:00	30	No	No GIT visual data.
27	31 July	212:19:05:54	212:19:23:35	30	No	No GIT visual data, lost power this tape.
28	1 Aug	213:19:34:00	213:20:02:58	30	No	GIT visual data, tape has time interruption.
29	1 Aug	213:20:24:37	213:20:49:37	30	No	Funnel sighted this tape.

(Continued)

TAPE NUMBER	DATE	ZULU TIME		TAPE SPEED	GIT SFERICS DATA	COMMENTS
		START	STOP			
30	1 Aug	213:20:55:53	213:21:08:05	60	No	GIT time correlated visual data.
31	1 Aug	213:21:12:10	213:21:24:15	60	No	GIT time correlated visual data.
32	1 Aug	213:21:26:39	213:21:50:38	30	No	GIT time correlated visual data.
33	1 Aug	213:21:55:04	213:22:07:16	60	No	GIT time correlated visual data.

TAPE RECORDER CHANNEL ASSIGNMENTS

CHANNEL ASSIGNMENTS 5-22 JULY 1977

CHANNEL	RECORD MODE	SIGNAL DESCRIPTION
1	Direct	3 MHz, LOG
2	Direct	30 MHz, LOG
3	Direct	3 MHz, LIN
4	Direct	30 MHz, LIN
5	Direct	VERT 295 MHz, LIN
6	Direct	HORIZ 139 MHz, LIN
7	Direct	VERT 139 MHz, LIN
8	Direct	HORIZ 295 MHz, LIN
9	Direct	ELEC. FIELD ANT. (FAST)
10	FM	ELEC. FIELD ANT. (FAST)
11	FM	ELEC. FIELD ANT. (SLOW)
12	FM	3 MHz, LIN
13	FM	VERT 139 MHz, LIN
14	FM	TIME CODE, EVENT MARKER, AND LIGHTNING COUNTER.

NOTE: (a) NOAA unit not used during the 1977 KSC Field Experiment.

CHANNEL ASSIGNMENTS 23 JULY 1977
(MORNING HOURS)

CHANNEL	RECORD MODE	SIGNAL DESCRIPTION
1	Direct	3 MHz, LOG
*2	Direct	30 MHz, LOG
3	Direct	3 MHz, LIN
*4	Direct	30 MHz, LIN
5	Direct	VERT 295 MHz, LIN
6	Direct	VERT 37.5 MHz, LIN (WJ)
7	Direct	VERT 139 MHz, LIN
8	Direct	HORIZ 295 MHz, LIN
9	Direct	ELEC. FIELD ANT. (FAST)
10	FM	ELEC. FIELD ANT. (FAST)
11	FM	ELEC. FIELD ANT. (SLOW)
12	FM	3 MHz, LIN
13	FM	VERT 139 MHz, LIN
14	FM	TIME CODE, EVENT MARKER AND LIGHTNING COUNTER

Note: These channel assignments are valid only for the morning of 23 July 1977.

* No data on these channels. Receiver was disconnected because signal levels were below a useful value.

CHANNEL ASSIGNMENTS 23-26 JULY 1977***

CHANNEL	DIRECT MODE	SIGNAL DESCRIPTION
1	Direct	3 MHz, LOG
*2	Direct	30 MHz, LOG
3	Direct	3 MHz, LIN
*4	Direct	30 MHz, LIN
5	Direct	VERT 295 MHz, LIN
6	Direct	Channel Unassigned
7	Direct	VERT 139 MHz, LIN
8	Direct	HORIZ 295 MHz, LIN
9	Direct	ELEC. FIELD ANT. (FAST)
10	FM	VERT 37.5 MHz, LIN (WJ)
** 11	FM	3 MHz, LIN
** 12	FM	ELEC. FIELD ANT (SLOW)
13	FM	VERT 139 MHz, LIN
14	FM	TIME CODE, EVENT MARKER AND LIGHTNING COUNTER

NOTE: * No data these channels; receiver was disconnected because signal levels were below a useful value.

** Channels were interchanged.

*** Channel assignments, 23 July are for afternoon hours only.

CHANNEL ASSIGNMENTS 26 JULY - 3 AUGUST 1977

CHANNEL	DIRECT MODE	SIGNAL DESCRIPTION
1	Direct	3 MHz, LOG
2	Direct	30 MHz, LOG (GIT)
3	Direct	3 MHz, LIN
4	Direct	ELEC. FIELD ANT (FAST)
5	Direct	VERT 295 MHz, LIN
*6	Direct	VERT 37.5 MHz, LIN (WJ)
7	Direct	VERT 139 MHz, LIN
8	Direct	HORIZ 295 MHz, LIN
9	FM	VERT 295 MHz, LIN
10	FM	VERT 37.5 MHz, LIN (WJ)
11	FM	ELEC. FIELD ANT. (SLOW)
12	FM	3 MHz, LIN
13	FM	VERT. 139 MHz, LIN
14	FM	TIME CODE, EVENT MARKER AND LIGHTNING COUNTER

NOTE: * Channel 6 is a swing frequency, check logs for proper operating frequency.

VISUAL/AURAL DATA LOG

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

12 July 77

TAPE NUMBER: 1

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 193:21:50:00

Stop 193:22:12:00

OBSERVERS: D. M. LeVine
C. S. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: *

Fast: *

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	0
H 139	0
V 295	0
H 295	0

*Values not logged.

2. VISUAL/AURAL DATA LOG

Tape #1

Time (Zulu)	Observations
No visual observation	

3. NOTES

a) Cal signal at end of tape.

b) Footage counter 3100 ft.

c) Stopped tape at 3125 ft.

d) Signals on this tape from a distant storm.

e) Good signal levels on 3 MHz and reasonably good on 139 MHz.

f) This tape is primarily for a system check.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

15 July 77

TAPE NUMBER: 2

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 196:20:56.55

Stop 196:21:20:14

OBSERVERS: C. S. Wilson
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	10
30	0
V 139	10
H 139	10
V 295	0
H 295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:56:55	a) Tape recorder on.
	b) No system calibration.
21:10:11	a) 3 MHz attenuator increased by 10 dB for a total of 20 dB.
21:20:14	c) End of tape.

3. NOTES

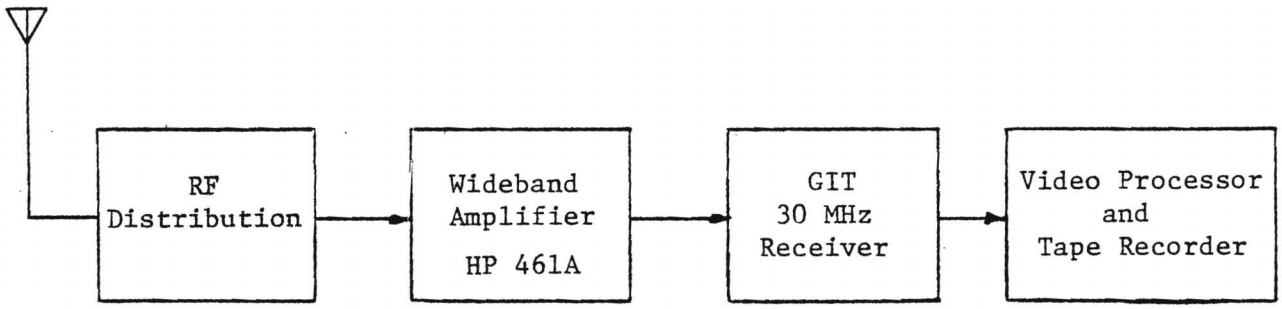
a) No visual data.

Signals from a distant storm.

No system calibration on this tape.

No GIT data.

b) There is a wideband amp in the 30 MHz channel (HP 461A) with 20 dB gain.



KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

18 July 77

TAPE NUMBER: 3

TAPE SPEED: 60 IPS

TEST LOCATION: Camera site UCS-12

ZULU TIME: Start 199:19:02:50

Stop 199:19:18:26

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	10
30	0
V 139	10
H 139	0
V 295	0
H 295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
18:59:00	a) System calibration on.
18:59:34	a) System calibration off.
19:02:50	a) Tape recorder on.
	b) No visual data.
19:04:39	a) Activity is very light.
	b) Krider is taking data.
19:08:00	a) Tape recorder off.
	b) Footage counter 1684 ft.
	c) Turned system off so that we could put the 30 MHz receiver signal through the Biomation and film on Krirder's system.
19:11:45	a) Tape recorder on.
19:17:15	a) System calibration on for the remainder of tape.
19:18:26	a) End of tape.

3. NOTES

a) The Lightning Counter was on during system calibration - this reading should be disregarded during system calibration.

b) This tape has time interruption.

c) Wideband amplifier is in line with the 37.5 MHz receiver.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

22 July 77

TAPE NUMBER: 4

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 203:17:30:51

Stop 203:17:54:43

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	10
H 139	0
V 295	0
H 295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
17:31:00	a) System calibration on.
17:31:20	a) System calibration off.
17:47:00	a) Vert 295 MHz attenuator is increased by 10 dB for a total of 10 dB.
	b) Horiz 139 MHz attenuator is increased by 10 dB for a total of 10 dB.
17:52:00	a) Krider is taking data on the 3 MHz channel.
17:54:13	a) System calibration on.
17:54:43	a) System calibration off.
	b) Tape off.

3. NOTES

a) S-band data is being collected by Dave Rust.

b) The 37.5 MHz receiver gain has been increased by approximately 6 dB.

Wideband amp is in line on the 37.5 MHz receiver.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

22 July 77

TAPE NUMBER: 5

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 203:18:09:13

Stop 203:18:33:13

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	10
V 139	10
H 139	10
V 295	10
H 295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
18:10:19	a) System calibration on.
18:10:40	a) System calibration off.
18:17:17	a) Vert 295 MHz attenuator decreased by 10 dB for a total of 0 dB.
18:27:20	a) Vert 130 MHz attenuator increased by 10 dB for a total of 20 dB.
18:28:26	a) 3 MHz attenuator increased by 10 dB for a total of 30 dB.
18:31:27	a) Electric Field Antenna gain setting to position 3.
18:33:13	a) End of tape.
	b) No system calibration.

3. NOTES

a) 30 MHz wideband amp is on.

b) Krider is taking 3 MHz data.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

22 July 77

TAPE NUMBER: 6

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 203:18:50:00

Stop 203:19:14:52

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 4

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V 139	30
H 139	20
V 295	10
H 295	20

2. VISUAL/AURAL DATA LOG

22 July 77

Time (Zulu)	Observations
18:50:59	a) Vert 139 MHz attenuator decreased by 20 dB leaving a total of 10 dB.
18:54:28	a) Horiz 139 MHz attenuator decreased by 10 dB leaving a total of 10 dB.
18:54:49	a) Horiz 139 MHz attenuator increased by 10 dB for a total of 20 dB.
18:55:41	a) 3 MHz attenuator decreased by 10 dB leaving a total of 20 dB.
18:59:00	a) Video Signals to Krider's van.

Cable	Signal
Loop 1	V139
Loop 2	V295
Vertical	3 MHz

19:03:00	a) 3 MHz attenuator decreased by 10 dB leaving a total of 10 dB.
	b) Vert 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
	c) Horiz 295 MHz attenuator decreased by 10 dB leaving a total of 10 dB.
	d) Horiz 139 MHz attenuator decreased by 10 dB leaving a total of 10 dB.
19:07:36	a) Horiz 139 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
19:11:42	a) Tape recorder stop; back on.
19:13:38	a) System calibration on.
19:14:52	a) System calibration off.
	b) End of tape.

3. NOTES

a) 30 MHz wideband amp off and out of the system this tape.

b) No system calibration at beginning of this tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

23 July 77

TAPE NUMBER: 7

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 204:14:50:02

Stop 204:15:00:24

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 4

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	20
V 37.5 (WJ)	50
V 295	0
H 295	0

2. VISUAL/AURAL DATA LOG

23 July 77

Time (Zulu)	Observations
14:50:35	a) System calibration on.
14:50:50	a) System calibration off.
	b) Krider is taking data using Vert 139 MHz, 20 dB Vert 37.5 (WJ), 50 dB
14:53:48	a) 3 MHz attenuator is increased by 10 dB for a total of 30 dB.
14:55:25	a) Electric Field Antenna to Position 3.
15:00:10	a) Tape recorder off at 3087 feet.
	b) Cables not connected for recording the 37.5 MHz (WJ).
15:11:16	a) Tape recorder on.
	b) Vert 139 MHz has 20 db attenuation Vert 37.5 MHz (WJ) has 30 dB attenuation.
15:11:43	a) Tape recorder stopped, back on immediately.
15:12:40	a) Video signals to Krider's van.

Cable	Signal
Loop 1	V139
Loop 2	3 MHz
Vertical	V37.5

b) No system calibration.

15:00:24 a) End of tape.

3. NOTES

a) The Horiz 139 MHz WJ Receiver was returned to 37.5 MHz. Therefore, there is no Horiz 139 MHz data. This receiver was tuned to various frequencies during the remainder of the experiment.

b) There is no calibration signal on the new 37.5 (WJ) channel. However, there is a 295 MHz calibration signal inserted in this channel during system calibration. We are using the 1 meter whip antenna for this channel.

c) The slow antenna channel saturates when it is raining and the DC level is unstable.

d) There is no GIT 30 MHz data this tape. Antenna was removed.

e) This tape has time interruption.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

23 July 77

TAPE NUMBER: 8

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 204:15:18:30

Stop 204:15:30:45

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 3

Fast: 3

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V 139	20
V 37.5 (WJ)	20
V 295	30
H 295	0

2. VISUAL/AURAL DATA LOG

23 July 77

Time (Zulu)	Observations
15:18:45	a) System calibration on.
15:19:00	a) System calibration off.
15:19:53	a) Tape recorder stopped.
15:19:54	a) Tape recorder on.
15:29:28	a) Tape recorder stopped.
15:29:29	a) Tape recorder on.
15:30:00	a) System calibration on.
15:30:45	a) System calibration off.
	b) End of tape.

3. NOTES

a) There is no H139 data this tape and for the remainder of the experiment.

b) There is no GIT 30 MHz data this tape.

c) There is no cal signal on the 37.5 WJ channel.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

23 July 77

TAPE NUMBER: 9

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 204:17:06:00

Stop 204:17:18:02

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 3

Fast: 3

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	0
V 37.5 (WJ)	30
V 295	0
H 295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
17:06:20	a) System calibration on .
	b) Krider taking data .
17:06:40	a) System calibration off.
17:07:36	a) Considerable noise and interference on the 37.5 MHz (WJ) channel.
17:11:10	a) Vertical 139 MHz attenuator increased by 10 dB for a total of 10 dB.
17:15:01	a) Krider is out of film.
17:18:02	a) End of tape.
	b) No system calibration.

3. NOTES

a) There is no GIT 30 MHz data this tape.

b) Video signals to Krider's van

Cable	Signal
Loop 2	3 MHz, 20 dB attenuation
Loop 1	V139, 0 dB attenuation increased by 10 dB at 17:11:10

c) No calibration signal on the 37.5 MHz (WJ) channel.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

23 July 77

TAPE NUMBER: 10

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 204:19:57:32

Stop 204:20:40:27

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	40
30	0
V 139	10
V 37.5 (WJ)	30
V 295	20
H 295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:00:46	a) 3 MHz attenuator decreased by 20 dB leaving a total of 20 dB.
20:01:37	a) Vert 139 MHz attenuator increased by 10 dB for a total of 20 dB.
20:40:27	a) End of tape.
	b) No system calibration.

3. NOTES

a) This tape has time interruption and testing at the end.

b) No GIT 30 MHz data this tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

23 July 77

TAPE NUMBER: 11

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 204:20:47:50

Stop 204:21:04:06

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	20
V 37.5	40
V 295	10
H 295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:51:35	a) System calibration on.
20:52:45	a) System calibration off.
20:54:34	a) We stopped tape recorder.
21:00:18	a) Restarted tape recorder.
21:04:46	a) End of tape.
	b) No system calibration.

3. NOTES

a) Krider and Uman taking data.

b) No calibration signal on the 37.5 MHz channel.

c) No GIT 37.5 MHz data this tape.

d) This tape has time interruption.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

27 July 77

TAPE NUMBER: 12

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 208:19:58:01

Stop 208:20:21:58

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	20
V 69 (WJ)	40
V 295	0
H 295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
19:45:43	a) Video signals to Krider's van. Cable — Signal Loop 1 — 3 MHz, 20 dB attenuation Loop 2 — V69, 40 dB attenuation Vertical — V139, 20 dB attenuation b) No data being taken by Krider.
19:58:01	a) Tape on. b) System calibration on.
19:59:36	a) System calibration off. b) Event button will be pushed twice (2) for thunder.
20:13:00	a) Event marker was not active until this time.
20:16:00	a) Vert 139 MHz attenuator decreased by 10 dB leaving a total of 10 dB.
20:16:30	a) Vert 69 MHz attenuator decreased by 10 dB leaving a total of 30 dB.
20:21:16	a) System calibration on.
20:21:58	a) System calibration off. b) End of tape.

3. NOTES

a) There is no calibration signal on the 69 MHz channel and we are using the 1 meter whip for the antenna.

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
21:04:56	a) System calibration on.
21:05:15	a) System calibration off.
	b) Video signals to Krider's van.

Cable	Signal
Loop 1	3 MHz, 10 dB attenuation
Loop 2	V69, 20 dB attenuation
Vertical	V139, 10 dB attenuation

	c) 69 MHz attenuator increased by 10 dB for a total of 20 dB.
21:31:33	a) System calibration on.
21:33:19	a) System calibration off.
	b) End of tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 77

TAPE NUMBER: 14

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:18:46:45

Stop 209:18:58:53

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V 139	10
V 69 (WJ)	30
V 295	0
H 295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
18:46:52	a) System calibration on.
18:47:30	a) System calibration off.
18:53:00	a) Krider off.
	b) Krider changing video combination.
18:52:39	a) C-G, event marker on.
18:54:42	a) Vert 295 MHz RF to Krider's van with 0 dB attenuation.
18:54:41	a) C-G, event marker on.
18:55:30	a) Krider taking video data.
18:56:20	a) Vert 139 MHz attenuator increased by 10 dB for a total of 20 dB.
18:58:30	a) System calibration on.
18:58:53	a) System calibration off.
	b) Tape recorder off.

3. NOTES

a) Video signals to Krider's van

Cable	Signal
Vertical	V139, 10 dB attenuation
Loop 1	V69, 30 dB attenuation
Loop 2	3 MHz, 20 dB attenuation

b) This tape has time interruption because Krider is changing his video combination.

c) C-G denotes cloud-to-ground lightning.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 15

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:19:02:05

Stop 209:19:14:12

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V139	20
V69 (WJ)	30
V295	0
H295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
19:02:05	a) No system calibration at beginning of of tape. b) Video signal to Krider's van. Cable — Signal Vertical — V139, 20 dB attenuation Loop 1 — V295, 0 dB attenuation Loop 2 — V69, 30 dB attenuation
19:05:00	a) Krider off.
19:05:50	a) System calibration on.
19:06:57	a) System calibration off.
19:07:12	a) Vert 69 MHz attenuator increased by 10 dB for a total of 40 dB.
19:09:56	a) 3 MHz attenuator increased by 10 dB for a total of 30 dB. b) Vert 295 MHz attenuator increased by 10 dB for a total of 10 dB. c) Horiz 295 MHz attenuator increased by 10 dB for a total of 10 dB.
19:13:38	a) System calibration on.
19:14:12	a) System calibration off. b) End of tape.

3. NOTES

a) Event marker is in operation on this tape.

b) The last event marker was pushed by mistake.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 16

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:19:16:56

Stop 209:19:41:04

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V69 (WJ)	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
19:16:56	a) System calibration on.
19:18:03	a) System calibration off.
19:20:30	a) GIT data on.
19:39:36	a) System calibration off.
19:41:04	a) System calibration off.
	b) End of tape.

3. NOTES

a) Krider and Uman taking data.

b) The event markers on all tapes are approximately 1-2 seconds late on each event.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 17

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:19:44:21

Stop 209:19:56:24

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V69 (WJ)	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
19:44:21	a) System calibration on.
19:45:38	a) System calibration off.
19:47:32	a) V69 MHz attenuator increased by 10 dB for a total of 50 dB.
19:55:29	a) System calibration on.
19:56:24	a) System calibration off.
	b) End of tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

23 July 1977

TAPE NUMBER: 18

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:20:00:52

Stop 209:20:13:34

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V69 (WJ)	50
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:01:00	a) System calibration on.
20:02:05	a) System calibration off.
20:03:04	a) Tape recorder off; checking demodulator card on channel 12.
20:03:37	a) Demodulator card not reproducing.
20:07:07	a) Checking event marker.
20:07:19	a) End of event marker test.
20:07:24	a) C-G occurred at the end of test not sure of this time.
20:10:11	a) GIT 37.5 MHz attenuator increased by 10 dB for a total of 10 dB.
20:11:00	a) Vert 139 MHz attenuator increased by 10 dB for a total of 30 dB.
20:13:21	a) System calibration on.
20:13:34	a) System calibration off.
	b) End of tape.

3. NOTES

a) This tape has some event marker test data.

b) This tape has time interruption.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 19

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:20:19:05

Stop 209:20:31:08

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	10
V139	30
V69 (WJ)	50
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time(Zulu)	Observations
20:19:05	a) System calibration on.
20:20:31	a) System calibration off.
20:28:03	a) C-G.
	b) Slanted left to right from the top.
	c) Single return stroke.
	d) A roll cloud is located in front of cell but appears to be breaking up.
20:29:18	a) I-C.
	b) Cell movement is to the west.
20:29:57	a) C-G.
	b) Three (3) different C-G out of the front of the roll cloud.
20:30:22	a) Thunder.
	b) This is a very isolated storm.
20:30:54	a) System calibration on.
20:31:08	a) System calibration off.
	b) End of tape.

3. NOTES

a) C-G denotes cloud-to-ground lightning,
I-C denotes intra-cloud lightning

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 20

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:20:34:25

Stop 209:20:46:33

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	10
V139	30
V69 (WJ)	50
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:34:25	a) Tape on.
	b) System calibration on.
20:35:36	a) This cell is drifting to the west and is passing over the coast. It may be caught up by the sea breeze and be pushed further inland.
20:38:01	a) C-G, single channel located west of Complex 39A.
20:38:07	a) C-G, behind Complex 39A.
20:39:13	a) Very heavy thunder.
	b) All of the lightning has been in the area of the roll cloud directly in front of the main cell.
20:46:10	a) System calibration on.
20:46:33	a) System calibration off.
	b) End of tape.

3. NOTES

a) This storm system is a single cell with a slow movement toward the southeast and is located approximately 20 miles from the field site. It is a well isolated cell and is the only one in the area. It is a typical convective cell which started developing over the water and moved eastward over the site with a roll cloud developing in front of the main cell. Most of the lightning that was visible came from the vicinity of the roll cloud and from the south edge of the cell.

The data on this storm is from the early stages of development through its complete life cycle. Dr. Krider and Dr. Uman took some data together during this thunderstorm.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 21

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:20:59:23

Stop 209:21:23:28

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	10
30	0
V139	10
V70 (WJ)	30
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:59:23	a) Tape on.
	b) System calibration on.
21:01:03	a) System calibration off.
21:23:26	a) System calibration on.
21:23:38	a) System calibration off.
	b) End of tape.

3. NOTES

a) There was a lot of interference on the V 69 MHz channel, therefore the receiver was retuned for 70 MHz at the beginning of this tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

28 July 1977

TAPE NUMBER: 22

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 209:21:28:30

Stop 209:21:40:34

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	10
30	0
V139	10
V70 (WJ)	30
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
21:28:30	a) Tape on.
	b) System calibration on.
	c) Video signals to Krider's van.

Cable	Signal
Vertical	V139, 10 dB attenuation
Loop 1	V70, 30 dB attenuation
Loop 2	3 MHz, 10 dB attenuation

21:29:30	a) System calibration off.
21:39:00	a) Krider off.
21:39:12	a) System calibration on.
21:40:34	a) System calibration off.
	b) End of tape.

3. U. OF A. VISUAL DATA LOG

28 July 1977

Observers: Karen Duck
C. D. Weidman
S. B. Hamilton

Location: Camera Site UCS-12

Time: Start 209:18:54:36

Stop 209:20:31:32

Time (Zulu)	Observations	Azimuth (deg)
18:54:36	C-G	240
18:55:12	C-G	235
18:55:48	C-G	238
18:56:44	C-G	235
18:56:44	C-G	238
18:57:13	C-G	236
19:28:41	C-G	260
19:28:41	C-G	300
19:53:28	C-G	300
19:54:20	C-G	280
19:55:57	C-G	290
19:56:31	C-G	300
19:57:16	C-G Maybe	285
20:00:12	C-G	310
20:02:20	C-G	310
20:07:33	C-G	290
20:09:46	C-G Maybe	290
20:10:43	C-G	290
20:11:02	C-G	288
20:13:25	C-G	290
20:13:40	C-G	290
20:14:54	C-G	280

28 July 1977

Time (Zulu)	Observations	Azimuth (deg)
20:16:01	C-G	295
20:16:20	C-G	298
20:17:07	C-C	290
20:18:00	C-G	280
20:18:39	C-G	280
20:19:04	C-G	290
20:20:15	C-C	270-285
20:21:02	C-G	290
20:22:07	C-C Maybe	280
20:24:15	C-G	275
20:24:15	C-G	285
20:24:36	C-G	300
20:25:17	C-G	310
20:25:33	C-G	295
20:25:33	C-G	305
20:26:18	C-G	300
20:27:06	C-G	305
20:27:26	C-G	290
20:28:02	C-G	280
20:29:15	C-G	290
20:29:54	C-G	285
20:29:54	C-G	303
20:31:26	C-G	265
20:31:32	C-G	280

28 July 1977

4. NOTES

a) C-G denotes cloud-to-ground lightning,

C-C denotes cloud to cloud lightning.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

30 July 1977

TAPE NUMBER: 23

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 211:19:34:09

Stop 211:19:58:30

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 4

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V139	10
V74 (WJ)	30
V295	0
H295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)		Observations
19:34:46	a)	System calibration on.
19:35:20	a)	System calibration off.
19:36:40	a)	3 MHz attenuator is increased by 10 dB for a total of 30 dB.
	b)	Vert 139 MHz attenuator is increased by 10 dB for a total of 20 dB.
	c)	Vert 295 MHz attenuator is increased by 10 dB for a total of 10 dB.
	c)	Vert 74 MHz attenuator is increased by 10 dB for a total of 40 dB.
19:37:37	a)	3 MHz attenuator is increased by 10 dB for a total of 40 dB.
	b)	Vert 139 MHz attenuator is increased by 10 dB for a total of 30 dB.
	c)	GIT 37.5 MHz attenuator is increased by 10 dB for a total of 10 dB.
19:37:52	a)	Thunder.
19:38:18	a)	Heavy Thunder.
19:39:19	a)	Elec. Field Ant.(EFA) to positon 3.
19:39:40	a)	Thunder.
19:40:27	a)	Flash.
19:40:29	a)	Thunder.
	b)	Storm is located within 1-2 miles of site. Both thunder and lighting very heavy.
19:41:28	a)	Flash.
19:41:44	a)	Thunder.
19:42:13	a)	C-G.

Time (Zulu)	Observations
19:42:23	a) Thunder.
19:42:49	a) Thunder.
19:43:07	a) Thunder.
19:43:23	a) Flash.
19:43:31	a) Thunder.
19:44:06	a) Raining.
19:44:26	a) Flash.
19:46:05	a) Flash.
19:46:27	a) Thunder.
19:47:14	a) Thunder.
19:47:26	a) Flash.
19:47:33	a) Thunder.
19:47:53	a) C-G.
19:48:12	a) Thunder.
19:48:43	a) Thunder.
19:49:05	a) Two (2) return strokes over water.
19:49:10	a) Thunder.
19:49:48	a) C-G.
	b) Flash.
19:50:04	a) Thunder.
19:50:30	a) Event marker operating.
19:56:28	a) End of tape sensor cut tape recorder off.
19:56:30	a) Recorder back on.
19:56:50	a) System calibration on.
19:57:40	a) System calibration off.
19:58:30	a) End of Tape.

3. NOTES

a) C-G denotes cloud-to-ground lightning.

b) Retuned the V70 MHz receiver to V74 MHz because of interference.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

30 July 1977

TAPE NUMBER: 24

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 211:19:59:55

Stop 211:20:04:22

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 3

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	40
30	10
V139	20
V74 (WJ)	30
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:00:08	a) System calibration on.
20:00:30	a) System calibration off.
20:00:50	a) 3 MHz attenuator decreased by 10 dB leaving a total of 30 dB.
20:01:43	a) Vert 74 MHz attenuator is increased by 10 dB for a total of 40 dB.
20:02:40	a) 3 MHz attenuator increased by 10 dB for a total of 40 dB.
20:04:22	a) Lost AC power to site.

3. Notes

a) We lost power to the site at 211:20:04:22

b) I restarted this tape at 212:01:24:56 See tape log 24A.

c) Time is accurate from 20' - 700' and from 700' to 3600' time is 3 sec fast.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

30 July 1977

TAPE NUMBER: 24A

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 212:01:24:56

Stop 212:01:46:09

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 3

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	10
V139	20
V74 (WJ)	40
V295	10
H-295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
01:24:56	a) Tape recorder on.
01:25:32	a) System calibration on.
01:26:05	a) System calibration off.
01:32:52	a) GIT lightning counter on.
01:39:36	a) Vert 139 MHz attenuator is increased by 10 dB for a total of 30 dB.
01:41:55	a) GIT 37.5 MHz attenuator is decreased by 10 dB for a total of 0 dB.
01:42:56	a) Recorder stopped, back on immediately.
01:43:51	a) Recorder stopped, back on immediately.
01:45:26	a) System calibration on.
	b) Tape recorder stopped again, back on.
01:46:09	a) System calibration off.
	b) End of tape.

3. NOTES

a) Time (from 700' - 3600') is 3 seconds fast.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

30 July 1977

TAPE NUMBER: 25

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 212:01:48:37

Stop 212:02:01:07

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	30
V74 (WJ)	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
01:49:08	a) System calibration on.
01:49:54	a) System calibration off.
01:50:12	a) Vert 139 MHz attenuator decreased by 10 dB leaving a total of 20 dB.
01:50:31	a) Vert 74 MHz attenuator decreased by 10 dB leaving a total of 30 dB.
01:50:45	a) Vert 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
	b) Horiz 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
01:51:37	a) Electric Field slow antenna gain to position
01:51:40	a) Electrical activity has decreased.
01:59:10	a) EOT sensor stopped tape recorder.
01:59:11	a) Recorder on.
01:59:35	a) System calibration on.
02:01:07	a) System calibration off.
	b) End of tape.

3. NOTES

a) The data on tapes 24A and 25 was taken at night.

b) I had several power problems after power was restored to the site. The main breaker in the outside power panel burned up. I had to get power from Dr. Krider's van in order to get any data.

2. U. of A. Visual Data Log

30 July 1977

Observers: Karen Duck
C. D. Weidman
S. B. Hamilton

Location: Camera site UCS-12

Time: Start 211:19:33:40
Stop 211:20:02:55

Time (Zulu)	Observations	Azimuth (deg.)	Thunder (sec)
19:33:40	C-G	230	-
19:35:12	C-G	280	21
19:36:03	C-G	2 @ 240;300	15.5
19:36:33	C-G	230	14
19:37:08	C-G	255	8
19:37:34	C-G	-	-
19:38:09	C-G	315	4.5
19:40:05	C-G	300	6
19:41:27	Inferred from strip chart		19 unobserved
19:42:49	C-G	330 ?	-
19:43:20	?	?	9
19:44:48	Flash	240	11
19:45:16	Flash	-	17.5
19:45:46	Flash	-	17
19:46:11	-	-	17
19:47:30	C-G	275	11
19:48:04	Flash	260	17
19:48:32	Flash	-	-
19:49:06	C-G	270	11
19:49:54	C-G	270	12

Time (Zulu)	Observations	Azimuth (deg.)	Thunder (sec.)
19:50:14	Flash	-	21
19:50:35	Flash	-	18.5
19:51:07	C-G	255	9
19:52:08	C-G	280	10.5
19:52:44	C-G	230	15
19:53:04	Flash	-	16
19:53:26	C-G	260	10
19:53:46	C-G	-	13
19:54:03	C-G	300	11.5
19:54:20	Flash	-	15.5
19:54:37	C-G	270	10
19:54:50	C-G	-	6.5
19:54:59	-	-	15.5 unobserved
19:55:19	C-G	290	15.5
19:55:45	C-G	280	6
19:57:18	Flash	-	7
19:58:20	Flash	-	12
19:59:40	Flash	-	-
20:02:32	Flash	-	-
20:02:55	-	-	-

Continued after power failure

Time (Zulu)	Observations	Azimuth (deg.)
00:17:38	C-G	270
00:17:52	C-G	Over Water
00:17:55	C-G	Over Water
00:18:15	C-G	0
00:19:24	C-G	350
00:20:12	C-G	300
00:20:30	C-G	350
00:21:17	C-C	Overhead
00:21:32	C-G	280
00:22:01	C-G	350
00:22:17	C-G	350
00:23:01	C-G	270
00:23:09	C-G	300 - 330
00:23:13	C-G	340
00:23:35	C-G	Over Water
00:24:31	C-G	10
00:28:05	C-G	Over Water
00:25:22	C-G	Over Water
00:26:00	C-G	Over Water
00:26:29	Not Sure	-
00:27:19	C-G	Over Water

Time (Zulu)	Observations	Azimuth (deg.)
00:27:51	C-G	Over Water
00:28:18	C-G	Over Water
00:28:29	C-C	-
00:28:42	C-G	-
00:30:05	C-C	Overhead
00:30:12	C-G	Over Water
00:30:24	C-G	Over Water
00:30:49	C-G	Over Water
00:30:59	C-G	Over Water
00:31:19	Not Sure	270
00:31:50	C-G	Over Water
00:32:42	C-G	Over Water
00:34:01	C-G	0 - 330
00:34:15	C-G	240
00:34:44	C-G	240
00:34:58	C-G	245
00:35:09	C-G	-
00:35:42	C-G	330
00:35:45	C-G	240
00:36:25	C-G	240
00:36:57	C-G	240
00:38:46	C-G	260
00:39:16	C-G	210

Time (Zulu)	Observations	Azimuth (deg.)
00:40:24	C-G	240
00:41:12	C-G	235
00:42:36	C-G	-
00:43:13	C-G	Over Water
00:43:45	C-C	-
00:45:01	C-C	-
00:45:56	C-C	-
00:46:32	Not Sure	330
00:48:13	Not Sure	-
00:48:16	Not Sure	All over
00:48:33	C-G	-
00:48:36	C-C	Over Water
00:48:43	C-C	Over Water
00:49:02	C-G	Over Water
00:49:20	Eight (8) separated channels to ground separated by several seconds between 00:49:20 to 00:50:00.	
00:50:02	C-G	0
00:50:34	C-G	Over Water
00:50:54	Not Sure	--
00:51:16	C-G	Over Water
00:52:58	C-C	-
00:53:47	C-G, Two (2) strokes	0, 30
01:03:47	C-C	
01:04:55	C-G	30
01:07:27	Not Sure	30

Time (Zulu)	Observations	Azimuth (deg.)
01:07:50	C-G	35
01:08:18	C-G	35
01:08:25	C-G	35
01:08:42	C-G	35
01:08:51	C-G	35
01:08:58	C-G	35
01:09:01	C-G	30
01:09:28	C-G	20
01:10:20	C-G	25
01:10:54	C-G	35
01:11:15	C-G	35
01:11:36	C-G	15
01:11:59	C-G	40
01:12:26	C-G	20
01:13:17	C-G	35
01:14:18	C-C	-
01:14:35	C-G	35
01:15:51	C-G	35
01:15:52	C-G	320
01:16:40	C-G	35

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

31 July 1977

TAPE NUMBER: 26

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 212:18:39:15

Stop 212:19:04:25

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V74 (WJ)	20
V295	0
H295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
18:39:30	a) System calibration on.
18:40:20	a) System calibration off.
18:41:02	a) V74 MHz (WJ) attenuator increased 10 dB for a total of 30 dB.
	b) Horiz 295 MHz attenuator increased 10 dB for a total of 10 dB.
18:42:43	a) Vert 295 MHz attenuator increased by 10 dB for a total of 10 dB.
18:56:30	a) V74 MHz attenuator increased 10 dB for a total of 40 dB.
19:02:41	a) EOT sensor stop tape recorder.
19:02:42	a) Tape recorder back on.
19:02:46	a) System calibration on.
19:04:25	a) System calibration off.
	b) End of tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

31 July 77

TAPE NUMBER: 27

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 212:19:05:54

Stop 212:19:23:35

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V74	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
19:05:54	a) System calibration on.
19:06:52	a) System calibration off.
19:08:04	a) V74 MHz attenuator increased 10 dB for a total of 50 dB.
19:08:29	a) 3 MHz attenuator increased by 10 dB for a total of 40 dB.
19:17:28	a) V74 MHz attenuator decrease by 10 dB leaving a total of 40 dB.
19:17:43	a) GIT 37.5 MHz attenuator increased by 10 dB for a total of 10 dB.
19:18:27	a) V74 MHz attenuator increased by 10 dB for a total of 50 dB.
19:22:35	a) Lost power to field site.
	b) End of tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

1 August 1977

TAPE NUMBER: 28

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 213:19:34:00

Stop 213:20:02:58

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	10
V139	10
V74	20
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
19:35:09	a) Vert 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
	b) Horiz 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
19:35:50	a) Thunder.
19:37:12	a) Thunder.
19:37:20	a) Thunder.
	b) C-G two (2) channels to water.
	c) Storm is over water.
19:40:25	a) Event button pushed by mistake.
19:41:50	a) GIT 37.5 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
19:50:39	a) EOT sensor cut tape recorder off.
19:50:40	a) Recorder back on.
19:50:55	a) System calibration on.
19:53:08	a) System calibration off.
	b) Tape off for system check.
19:57:35	a) Tape recorder on.
19:57:56	a) System calibration on.
19:58:35	a) System calibration off.
20:00:05	a) Tape recorder stopped.
20:00:06	a) Tape recorder back on.
20:02:58	a) End of tape.

3. NOTES

a. This tape has time interruptions

b. The Horiz 295 MHz antenna cable off. There is no Horiz 295 data this tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

1 August 1977

TAPE NUMBER: 29

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 213:20:24:37

Stop 213:20:49:37

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V139	20
V74 (WJ)	20
V295	0
H295	0

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:24:37	a) Tape on, no system calibration.
20:26:04	a) Funnel cloud sighted.
20:32:40	a) Funnel cloud dissipated.
	b) See attached description.
20:43:54	a) V74 MHz attenuator increased by 10 dB for a total of 30 dB.
20:46:45	a) Tape recorder off.
20:47:18	a) Tape on.
	b) System calibration on.
20:49:37	a) System calibration off.
	b) End of tape.

3. NOTES

a) The funnel cloud ended with an unusual change of shape. See Figure 1.

b) There were tornado warnings out for Brevard County. A tornado was reported between Titusville and Mins, Fla. (via TV forecast)

c) The thunderstorms seemed to line up from about 210° to directly north over the water as depicted in Figure 2. The system began as a small thunderstorm (1) moved out over the water. (We took RF data with Krider between 19:30 - 20:00 hrs, (Tape 28). Thunderstorm 2 developed and moved north and toward the water producing the funnel cloud (Tapes 29 & 30). The funnel data is on tape 29. Thunderstorm 2 moved out over the water and persisted for some time. Thunderstorm 3 then developed and for a while both storms 2 and 3 were active. Tapes 32 and 33 were almost entirely of storm 3. Tape number 31 has data on storm 2 and some data for storm 3. Thunderstorm number 3 stopped moving in the vicinity of the VAB (≈240°) and then dissipated. During the development of thunderstorm 2 there were only a few rain showers visible.

   Thunderstorm number 1 was very small and the storm system moved rapidly until thunderstorm 3 ceased to move. The winds then shifted from out of the south to out of the north during the decaying stages of the storm system.

"A funnel cloud touched down briefly near a moble home park in Mims, Fla. late Monday afternoon, but caused no damage, officials reported.

A spokesman for the Brevard Sheriff's Department said the funnel hit near Northgate Mobile Home Park on U. S. 1 at about 4:15 pm.

The cloud was visible for several miles, but finally dissipated, although it was followed by heavy thundershowers throughout North Brevard [1]."

[1] Today, Cocoa, Fla. 2 August 1977. (direct quotation from local newspaper)

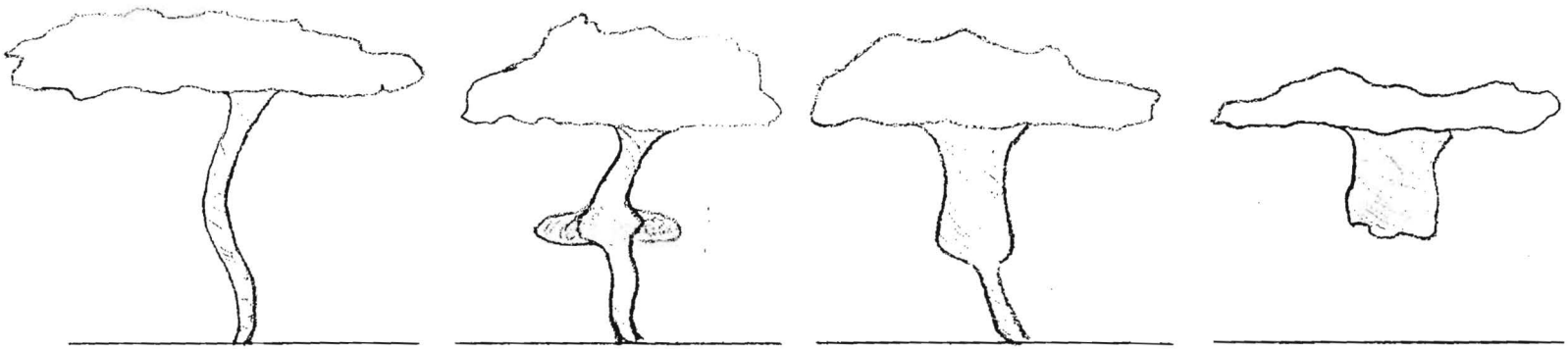


Figure 1. Funnel Cloud of 1 August 1977.

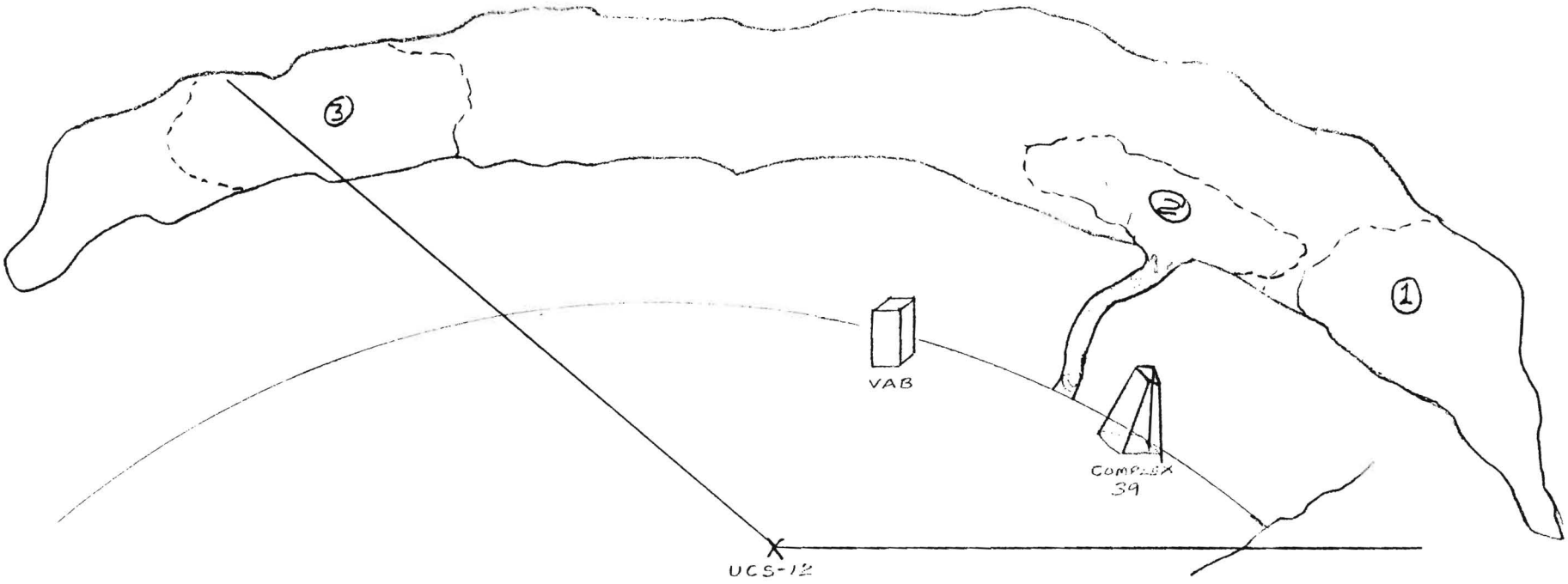


Figure 2. Storm System of 1 August 1977.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

1 August 1977

TAPE NUMBER: 30

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 213:20:55:53

Stop 213:21:08:05

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	10
V74	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
20:56:53	a) No system calibration.
	b) Vert 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
	c) Horiz 295 MHz attenuator decreased by 10 dB leaving a total of 0 dB.
20:56:54	a) C-W.
20:58:32	a) GIT 37.5 MHz attenuator increased by 10 dB for a total of 10 dB.
20:58:40	a) C-G, three (3) distinct channels about 270°.
20:59:20	a) Vert 295 MHz attenuator increased by 10 dB for a total of 10 dB.
	b) Horiz 295 MHz attenuator increased by 10 dB for a total of 10 dB.
21:00:39	a) Vert 139 MHz attenuator increased by 10 dB for a total of 20 dB.
21:00:45	a) These two (2) event markers are for a FLASH.
21:04:52	a) C-W, single channel multi-return strokes.
21:06:01	a) C-W, single channel about 330°.
21:07:22	a) C-G, single channel multi-return strokes.
21:07:29	a) System calibration on.
21:08:05	a) System calibration off.
	b) End of tape.

3. NOTES

a) C-W denotes cloud-to-water lightning.
C-G denotes cloud-to-ground lightning.

b) The event marker is for C-G only.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

1 August 1977

TAPE NUMBER: 31

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 213:21:12:10

Stop 213:21:24:15

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	20
30	0
V139	20
V74	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zula)	Observations
21:14:20	a) No system calibration.
	b) C-G, single channel multi-return stroke.
21:15:29	a) C-W, three (3) distinct channels.
21:16:48	a) C-G, single channel return stroke.
21:18:50	a) C-W, single channel.
21:19:02	a) C-W, two channels.
21:20:50	a) 3 MHz channel saturated.
21:21:07	a) 3 MHz channel saturated.
21:21:23	a) 3 MHz attenuator increased by 10 dB for a total of 30 dB.
21:22:54	a) System calibration on.
21:24:15	a) System calibration off.
	b) End of tape.

3. NOTES

a) This storm system extended in line from about 210° - 10° with a very large roll could and some movement toward the east.

b) The event marker is about 1 - 2 seconds late.

c) C-W denotes cloud-to-water lightning.
C-G denotes cloud-to-ground lightning.

d) The event marker is used to identify a cloud-to-ground discharge only.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

1 August 1977

TAPE NUMBER: 32

TAPE SPEED: 30 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 213:21:26:39

Stop 213:21:50:38

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V74	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)		Observations
21:26:39	a)	System calibration on.
21:28:34	a)	System calibration off.
21:29:25	a)	C-G, single channel.
21:30:05	a)	New storm developing to the west.
	b)	C-G, single channel about 240°.
21:30:14	a)	C-G, multiple channel 2 and possible 3 channels.
	b)	The lightning is coming from the southwest side of the storm system.
21:31:07	a)	C-G, could be multiple channel about 240°.
21:31:25	a)	C-G, single channel.
21:31:32	a)	C-G, single channel.
21:36:42	a)	C-W, single channel.
21:38:25	a)	C-G, single channel about 250° left of VAB.
	b)	Most all of the lightning is coming from the new storm which developed to the west of the field site.
21:39:18	a)	C-G, single channel about 255° coming from the edge of the storm.
21:40:02	a)	C-G, single channel behind VAB.
21:40:25	a)	C-G, single channel about 255°.
21:40:48	a)	C-G, single channel behind VAB.
	b)	Most of the lightning is coming from the leading edge of the storm that is west of us.

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
21:41:16	a) C-G, single channel with multiple return strokes by the VAB.
21:42:40	a) C-G, single channel.
21:43:09	a) C-G, single channel about 250° by the VAB.
	b) Lightning is from southwest side and behind storm systems.
21:44:32	a) C-G, single channel about 240°.
21:45:42	a) I-C very extensive.
21:48:19	a) I-C very extensive.
21:48:47	a) I-C.
21:49:16	a) System calibration on.
21:50:38	a) System calibration off.
	b) End of tape.

3. NOTES

a) Event marker for cloud-to-ground discharges only.

b) C-G denotes cloud-to-ground lightning.
C-W denotes cloud-to-water lightning.

c) Almost all of the lightning was produced by the thunderstorm to the west and came mostly from the southwest side of the storm.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

VISUAL/AURAL DATA LOG

1 August 1977

TAPE NUMBER: 33

TAPE SPEED: 60 IPS

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 213:21:55:04

Stop 213:22:07:16

OBSERVERS: D. M. LeVine
B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

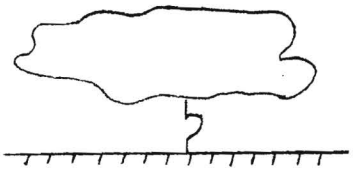
Slow: 5

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	30
30	0
V139	20
V74	40
V295	10
H295	10

2. VISUAL/AURAL DATA LOG

Time (Zulu)	Observations
21:55:04	a) System calibration on.
21:56:10	a) System calibration off.
21:56:17	a) C-G single channel, many return strokes but they came in groups separated by distinct pauses. 
21:56:59	a) C-G. b) Movement is to the north and the storm to the west has stalled behind the VAB.
21:59:23	a) I-C very extensive.
22:06:24	a) System calibration on.
22:07:16	a) System calibration off. b) End of tape.

GROUND-BASED FIELD OPERATION DATA LOG

THUNDERSTORM RESEARCH INTERNATIONAL PROJECT
TRIP-78
KENNEDY SPACE CENTER, FLORIDA

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

17 July - 27 July 1978

Contract NAS5-24148

By

C. S. Wilson and B. J. Wilson

FOREWORD

This document was prepared by the Engineering Experiment Station at Georgia Tech under Contract NAS5-24148. The data gathering and documentation effort was performed by personnel of the Electronics Technology Laboratory, Communications Technology Group, and was conducted under the general supervision of Mr. D. W. Robertson, Laboratory Director, and Mr. R. W. Moss, Group Head. Mr. C. S. Wilson was Project Director. This document presents a general description and the observer's summary of the ground-based field experiment conducted at the Kennedy Space Center, Florida during July 1978. The information contained in this document, in conjunction with the associated magnetic tape recordings and data plots of the sferic signals, provides the data information specified in Article II, Item 4 of the subject contract.

The overall guidance of Dr. D. M. LeVine of NASA is gratefully acknowledged.

INTRODUCTION

This document presents a summary of general and specific observations associated with the Kennedy Space Center, Florida ground-based experiments that were conducted between 17 July and 27 July 1978. All data were obtained with the Georgia Tech van located at camera site UCS-12.

This document consists of the following sections:

- Summary of Data Charts which provide a listing of all X-Y plots and the date, instrumentation settings, and related notes associated with each plot. Approximately 600 data charts were obtained during the field operation.

- Summary of Data Tapes which provides a listing of all the magnetic recording tapes and the date, time, tape speed and abbreviated comments associated with each tape.

- Tape Recorder Channel Assignments which lists the input signal source, the manner in which the signal was recorded (FM or direct), and the assigned channel of the Ampex PR 2200 tape recorder.

- Equipment Interconnections showing in block diagram form the manner in which instrumentation was interconnected for both test and data collection functions.

- Operational Data Log which provides detailed and specific information regarding the observer's comments and equipment settings.

SUMMARY OF DATA CHARTS

DATA CHART RECORD

18 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1A-3A	0.1	0.1	3
1B-5B	0.01	0.1	5
1C-5C	0.2	0.1	5
1D	0.5	0.1	1
1E-3E	0.05	0.1	3
1F-7F	0.1	0.1	7
1G-6G	0.01	0.1	6
1H-8H	0.2	0.1	8
1I-8I	0.05	0.1	8

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes		Intra-Cloud	
Quantity	Sample Interval	Quantity	Sample Interval
28	Values not logged	16	Values not logged

DATA CHART RECORD

19 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-3	0.1	0.1	3
4-20	0.1	0.2	17
21A-24A	0.05	0.2	4
25B-45B	0.05	0.1	20
46C-53C	0.01	0.1	7
54G	0.1	0.1	1
55G-67G	0.01	0.1	11

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes

Quantity	Sample Interval
21	0.1
16	0.05
19	0.01

Intra-Cloud

Quantity	Sample Interval
5	0.05
2	0.01

DATA CHART RECORD

20 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-14	0.1	0.1	14
1-5	0.1(i)	0.1	5

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes		Intra-Cloud	
Quantity	Sample Interval	Quantity	Sample Interval
17	0.1	2	0.1

i) This group of 5 plots consists of both first return strokes and 3 MHz data.

DATA CHART RECORD

21 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-5	0.1	0.1	5
6A-12A	0.05	0.1	7
13B-15B	0.1	0.1	3
16C-17C	0.05	0.1	2
18D-22D	0.05(i)	0.1	5
23E-26E	0.05(j)	0.05	4
27F-31F	0.1	0.05	5
32G-36G	0.1	0.05	5
37H-40H	0.2	0.05	4
41I-46I	0.5	0.05	6
47J-48J	1.0	0.05	2
49K-51K	0.1	0.05	3

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes

Quantity	Sample Interval
3	1.0
5	0.5
4	0.2
14	0.1
10	0.05

Intra-Cloud

Quantity	Sample Interval
11	0.05
5	0.1

i) Trigger derived from V-139

j) Trigger derived from 3 MHz

DATA CHART RECORD

22 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-3	0.05	0.05	3
3A	0.5	0.1	1
4-6	0.05	0.05	3
6A	0.5	0.1	1
7-8	0.05	0.05	2
9B-17B	0.5(i)	0.1	9
18C	0.05	0.05	1
19D-22D	0.05	0.1	4
23E	0.2	0.1	1
24F-37F	0.05	0.1	14

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes

Quantity	Sample Interval
20	0.05

Intra-Cloud

Quantity	Sample Interval
16	Varying sample intervals

i) Trigger derived from 3 MHz

DATA CHART RECORD

24 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-7	0.05	0.1	7
8A-11B	0.5	0.1	4
12C-50C	0.05	0.2	39
A-L	0.1(i)	0.05	12

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes

Quantity	Sample Interval
48	0.05
1	0.1

Intra-Cloud

Quantity	Sample Interval
7	0.05
3	0.5

i) Subsequent return strokes (Biomation armed on first return stroke).

j) Relatively close storm (approx. 20 km) north and east, lasting from about 1300-1530 hours EDT.

DATA CHART RECORD

25 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-2	0.05	0.05	2
3A-51A	0.05	0.1	49
52B-62B	0.05	0.05	11
63C	0.05(i)	0.05	1
64D-65D	0.2	0.1	2
66E-78E	0.05	0.1	13
79F-83F	0.05	0.1	5
84G-85G	0.05	0.05	2
86H	0.05(j)	0.05	1
87I-93I	0.05(k)	0.05	7
94J-111J	0.05(l)	0.1	18

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes		Intra-Cloud	
Quantity	Sample Interval	Quantity	Sample Interval
4	0.01	25	0.05
86(m)	0.05		
2	0.2		

i) Intra-cloud pulses

j) Trigger derived from V-139

k) Trigger derived from 3 MHz

l) Internal trigger

m) Includes 17 subsequent return strokes

DATA CHART RECORD

26 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1-9	0.2	0.05	9
10A-26A	0.05	0.05	37
27B-36B	0.05	0.1	10
37C-44C	0.2	0.05	8
45D-50D	0.1	0.05	6
51E-55E	0.05	0.05	5
56F-59G	0.05	0.05	4
60H-66H	0.02	0.05	7
61I-72J	0.05	0.05	12
73K-90K	0.05	0.05	18

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes		Intra-Cloud	
Quantity	Sample Interval	Quantity	Sample Interval
53(i)	0.05	10	0.05
7(j)	0.1	6	0.1
3(k)	0.2	10	0.2

i) Includes 5 subsequent return strokes.

j) All are subsequent return strokes.

k) Includes 2 subsequent return strokes.

DATA CHART RECORD

27 July 1978

Data Chart Number	Sample Interval (SR) (microseconds)	Input Level (IL) (volts)	Quantity
1A-10A	0.05	0.1	10
11A-20A	0.1	0.05	10
21C-30C	0.1	0.1	10
31D-69D	0.05	0.1	39
70E-74E	0.05	0.2	5
75F-77F	0.1	0.1	3
78G-89H	0.05	0.1	12
91I-99K	0.05	0.1	9
100-116	--- see note(i)	---	17

Notes

a) Sample Interval (SR) is the time base setting on the Biomation.

b) Input Level (IL) is the input level setting on the Biomation.

c) Peak Volts (PV) is the output voltage of the Biomation.

d) Fast E setting is 4.

e) X-Y recorder is set on 50 mv/division (CAL) for all data charts unless otherwise noted.

f) Full scale X axis deflection time is 20 seconds for all plots.

g) Sweep rate on all X-Y plots is 0.024 Hz (external sweep source).

h) First Return Strokes		Intra-Cloud	
Quantity	Sample Interval	Quantity	Sample Interval
68(j)	0.05	21	0.05
33(k)	0.1		

i) Various sample rates and input level settings; refer to data plots for specifics.

j) Includes 17 subsequent return strokes.

k) Includes 1 subsequent return stroke .

SUMMARY OF DATA TAPES

NUMBER	DATE	START	STOP	SPEED	DATA	COMMENTS
1	7-19-78	200:18:22:00	200:19:54:39	15	None	Channel 2,9 Have fast E data
2	7-19-78	200:19:41:30	200:20:31:40	15	None	Power failure
3	7-19-78	200:20:47:03	205:21:47:03	15	None	This tape has four (4) days of data
4	7-24-78	205:18:06:48	206:22:00:40	15	None	This tape has two (2) days of data
5	7-26-78	207:19:18:36	208:18:14:18	15	None	This tape has two (2) days of data
6	7-27-78	208:18:21:03	208:20:52:20	15	None	This tape has data on the first 1000' only.
	Note: All data tapes have time interruptions					

TAPE RECORDER CHANNEL ASSIGNMENTS

Channel Assignments - 16 July 1978

Channel	Operation Mode	Signal Description
1	Direct	3 MHz, Log
2	Direct	30 MHz, Log
3	Direct	3 MHz, Lin
4	Direct	E field fast(4)
5	Direct	V 295 MHz, Lin
6	Direct	V 69.0, Lin (swing channel)
7	Direct	V 139 MHz, Lin
8	Direct	H 295 MHz, Lin
9	FM	V 295 MHz, Lin
10	FM	V 69.0 Lin (swing channel)
11	FM	E field slow
12	FM	3 MHz, Lin
13	FM	Vert. 139 MHz, Lin
14	FM	Time code event marker and lightning counter

Note: Channels 6 & 10 are swing frequency, check logs for proper operating frequency.

Channel Assignments - 19 July 1978

Channel	Operation Mode	Signal Description
1	Direct	3 MHz, Log
2	Direct	Fast E 4 (Digitized)
3	Direct	3 MHz, Lin
4	Direct	Fast E, 4
5	Direct	V 295, Lin
6	Direct	V 69 MHz (swing)
7	Direct	V 139 MHz, Lin
8	Direct	H 295 MHz, Lin
9	FM	Fast E 4 (Digitized)
10	FM	V 69 MHz (swing)
* 11	FM	Slow E
12	FM	3 MHz, Lin
13	FM	V 139 MHz, Lin
14	FM	Time code, event marker and lightning counter.

*No antenna connected to slow E

EQUIPMENT INTERCONNECTIONS

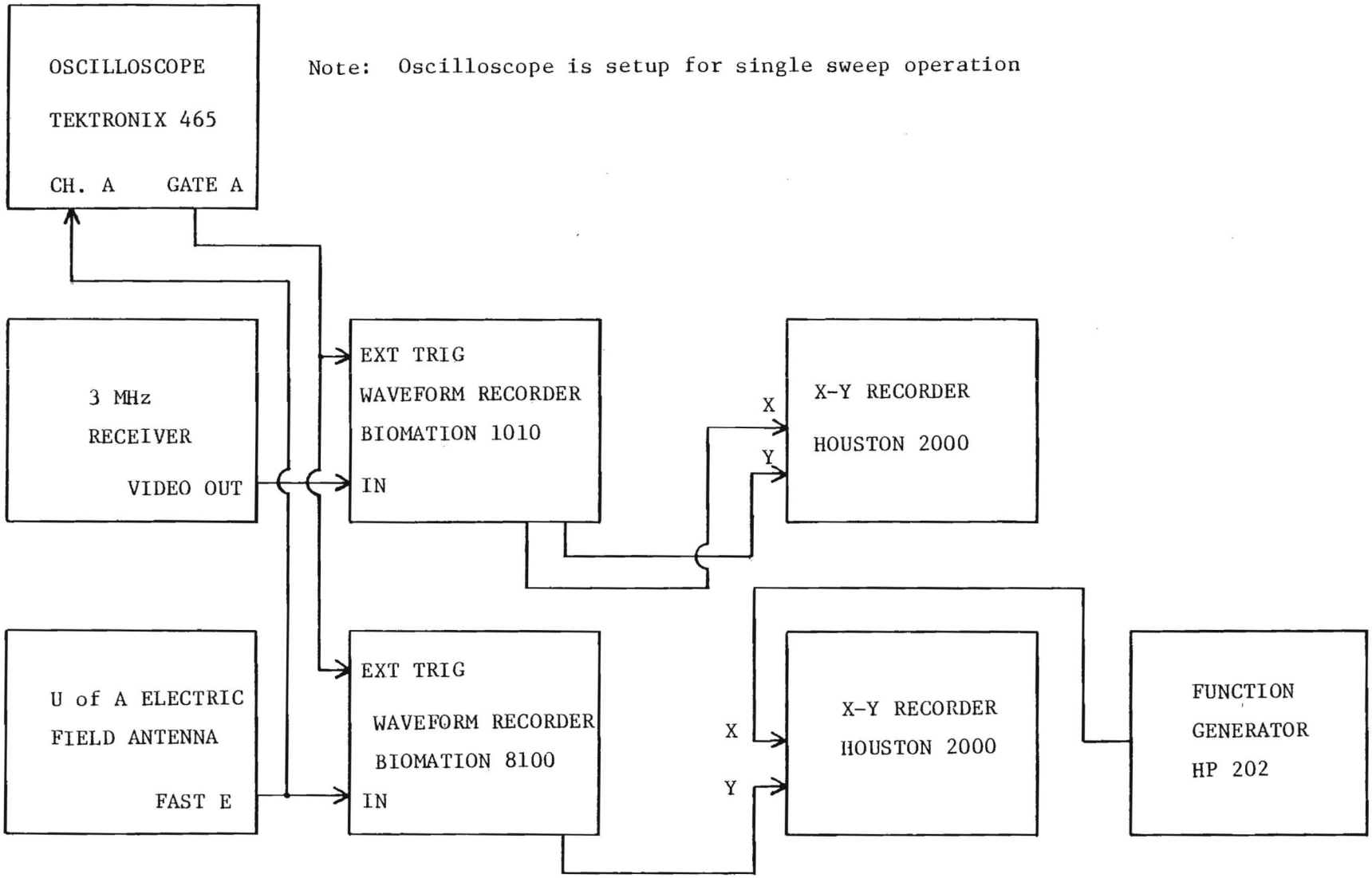


Figure 1 . Test Setup for Recording Both 3 MHz and Fast E Data

Note: This test setup applies to plots with letters in upper right hand corner of data plots.

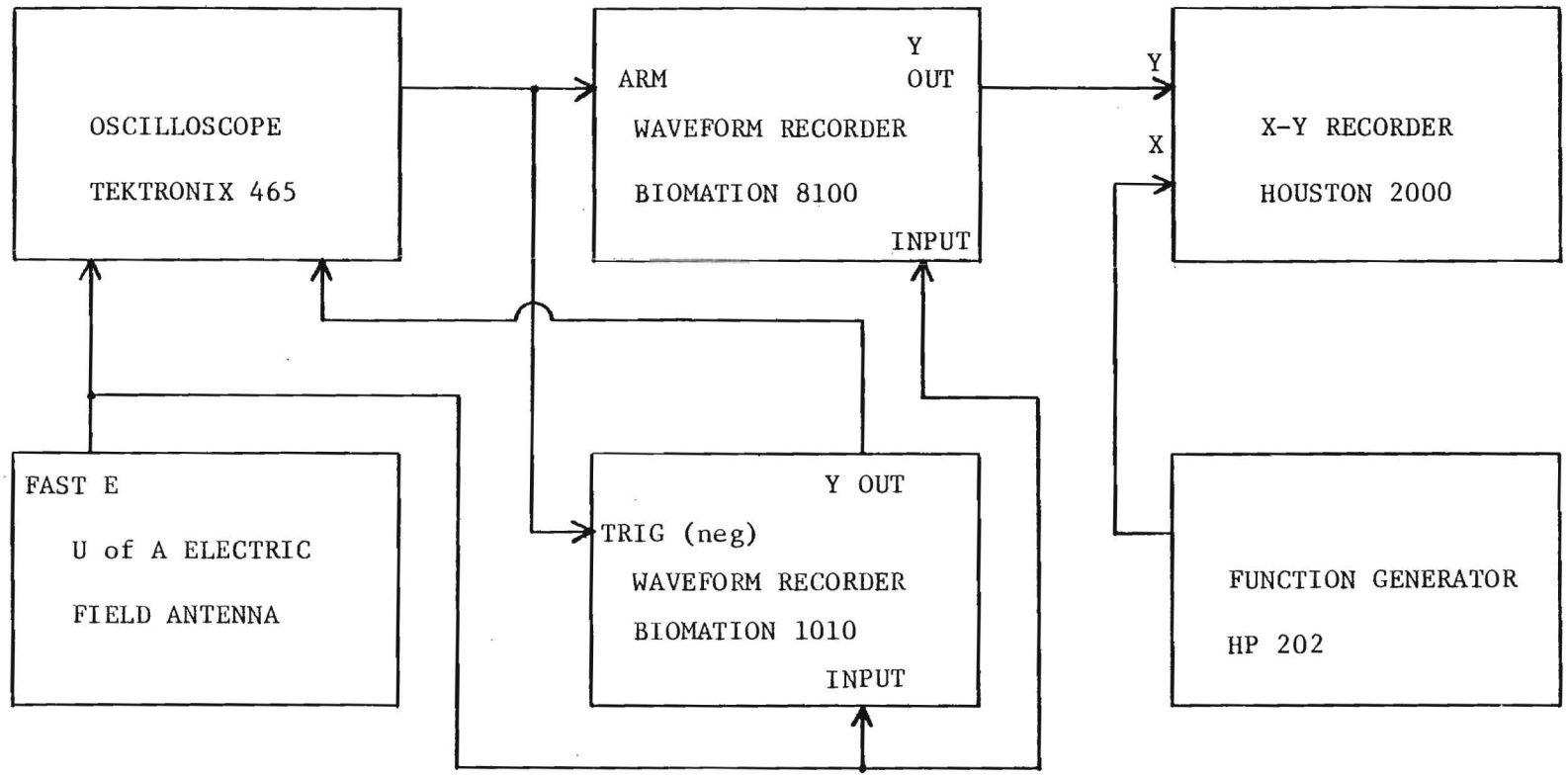


Figure 2 . Test Setup for Observing Delayed (950 μs) Signals from Electric Field Antenna (i.e. subsequent return strokes)

Notes: a) Biomation sample rate = 0.1 microseconds
b) Pulse generator output level = 0.1 volt peak-to-peak
c) Biomation INPUT level setting = 0.1 volt
d) X-Y recorder Y GAIN = 50 mv/div. (CAL)

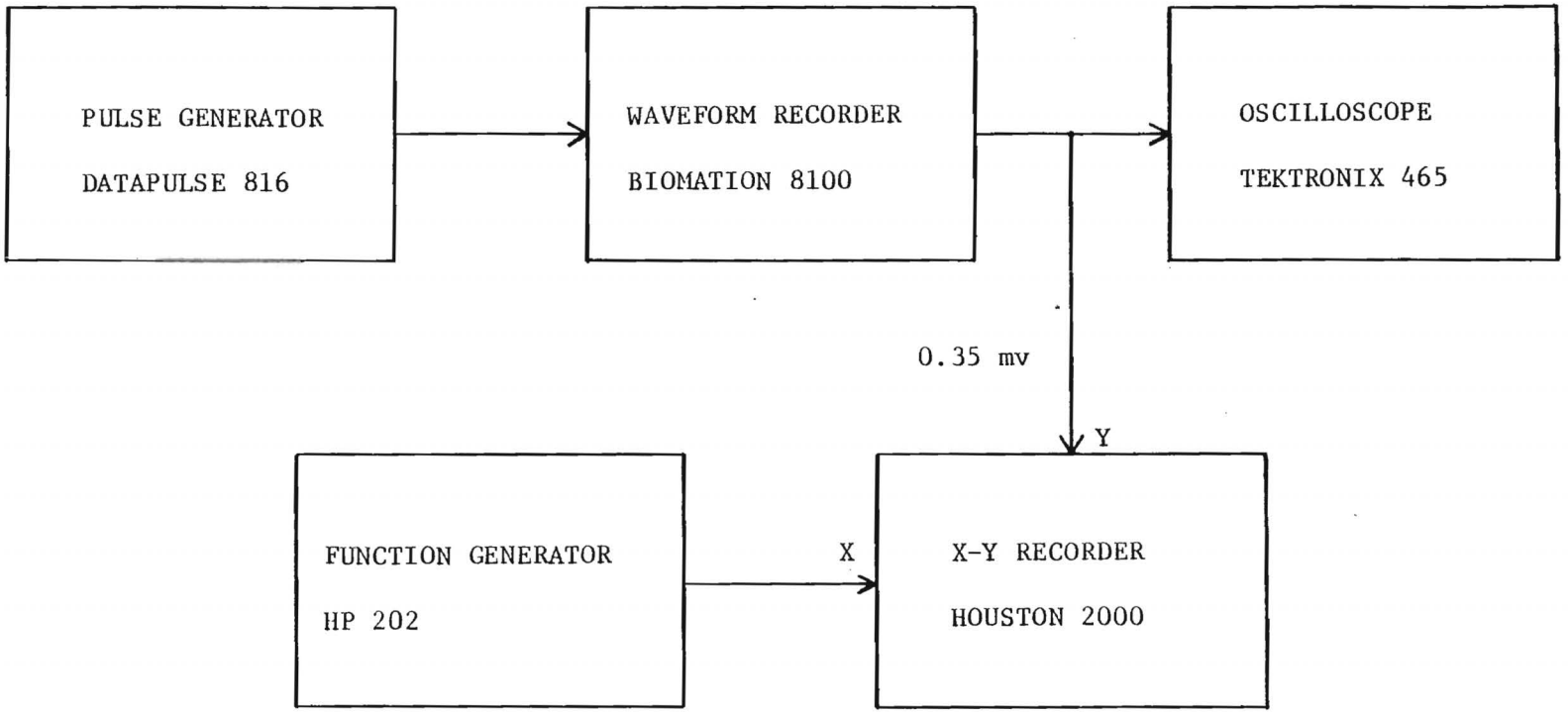


Figure 3 . Pulse Waveform Test Setup for Calibration.

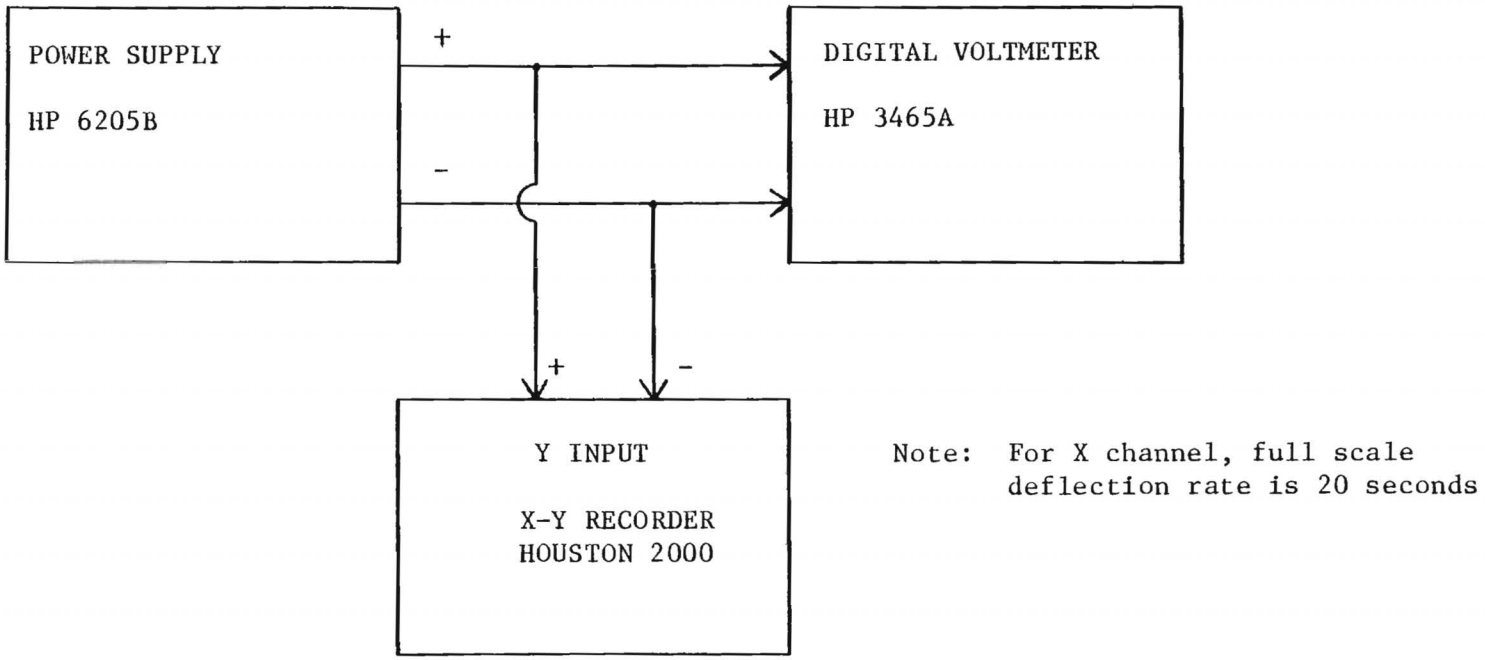


Figure 4. Test Setup for Calibration of X-Y Recorder.

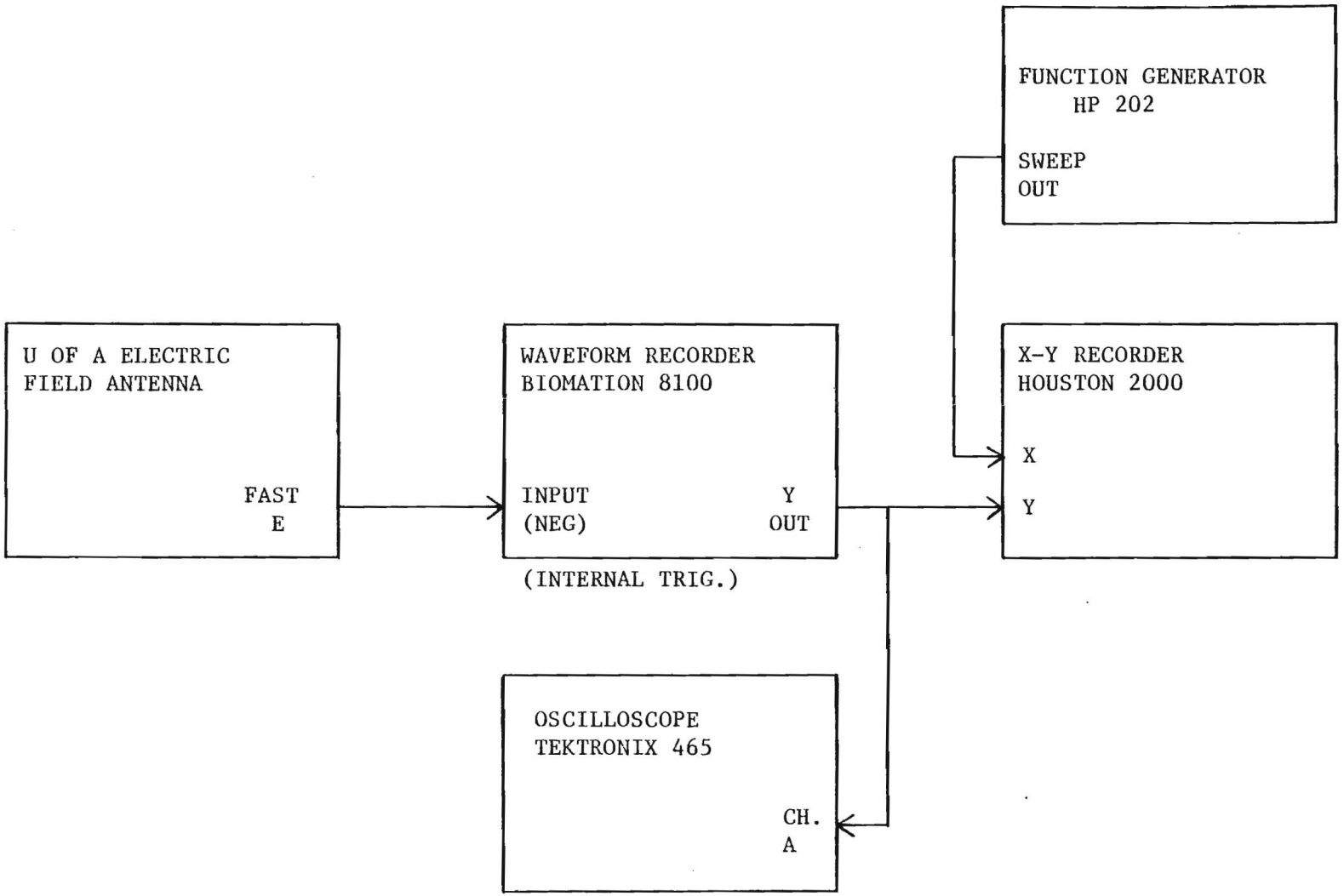


Figure 5. Test Configuration for Data Collection

OPERATIONAL DATA LOG

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

DATA LOG

19 July 78

TAPE NUMBER: 1

TAPE SPEED: 15

TEST LOCATION: Camera site UCS-12

ZULU TIME: Start 200:18:22:00

Stop 200:19:54:39

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: *

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	40
30	-
V 139	10
V 69 (WJ)	50
H 295	20
V 295	20

*No antenna connected to the slow E

2. 19 July 78 Data Log

Tape #1

Time (Zulu)	Observations
18:22:00	a) Tape recorder on. b) No cal signal.
18:39:00	a) Time code generator on.
18:47:36	a) Raining very heavy.
19:00:00	a) Power failure.
19:03:34	a) Power back on. b) Reset time code generator.
19:54:39	a) Tape recorder off. b) No cal signal.

3. Notes

a) Event market on, being activated by U. of Arizona personnel.

b) H139 channel was designated as a swing channel. The H139 antenna was removed and replaced with a 2 meter whip.

c) Channels 2, 9 were used to record digitized Fast E data.

d) No calibration signals on Channels 6, 10, because of the frequency they are being operated.

e) Time code generator is 1 hr. fast.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

DATA LOG

19 July 78

TAPE NUMBER: 2

TAPE SPEED: 15

TEST LOCATION:

ZULU TIME: Start 200:19:41:30

Stop 200:20:31:40

OBSERVERS: B. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: *

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	40
30	0
V 139	20
V 69 (WJ)	50
V 295	20
H 295	20

*No antenna connected to the slow E.

2. 19 July 78 Data Log

Tape #2

Time (Zulu)	Observations
19:41:30	a) Tape recorder on.
19:41:40	a) System calibration on.
19:42:37	a) System calibration off.
19:44:00	a) Power failure.
19:46:00	a) Tape recorder back on after power failure.
20:06:50	a) Changed input level on Biomation from .2 Volts to .1 Volt.
20:31:40	a) Tape recorder off. b) No system calibration.

3. Notes

a) Digitized Fast E data is being recorded on Channels 2,9.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

DATA LOG

19 July 78

TAPE NUMBER: 3

TAPE SPEED: 15

TEST LOCATION: Camera Site USC-12

ZULU TIME: Start 200:20:40:30

Stop 203:21:47:03

OBSERVERS: B. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: *

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	40
30	0
V 139	20
V 69 (WJ)	50
V 295	20
H 295	20

*Value not logged

2. 19 July 1978 Data Log

Tape #3

Time (Zulu)	Observations
20:40:30	a) Tape on. b) No system calibration. c) Change sample interval on the Biomation from .01 μsec to .1 μsec.
20:43:50	a) Tape recorder off.
20:45:22	a) Tape recorder on.
20:46:18	a) Tape recorder off.
20:48:54	a) Arm button on Biomation was reset. Retaped this plot. b) No X-Y plot of this data.
20:49:30	a) Tape recorder off. b) No system calibration.

3. Notes

a) Time code generator 1 hour fast.

b) No antenna connected to the slow E channel.

c) This tape has some digitized Fast E data on Channels 2 and 9.

2. 20 July 1978 Data Log

Tape #3

Time (Zulu)	Observations
22:27:30	a) Fast E data Channel 9 only. b) Tape recorder on.
22:33:49	a) Tape recorder off.
22:36:39	a) Tape recorder on.
22:37:10	a) Tape recorder off.
22:38:50	a) Tape recorder on.
22:39:10	a) Tape recorder off.
22:40:19	a) Tape recorder on.
22:40:37	a) Tape recorder off.
22:41:30	a) Tape recorder on.
22:41:57	a) Tape recorder off.
22:42:54	a) Tape recorder on.
22:43:24	a) Tape recorder off.
22:44:52	a) Tape recorder on.
22:45:10	a) Tape recorder off.
22:47:24	a) Tape recorder on.
22:47:45	a) Tape recorder off.

3. Notes

a) Time code generator is 1 hour fast.

b) This is a continuation of Tape #3.

2. 21 July 1978 Data Log

Tape #3

Time (Zulu)	Observations
21:01:03	a) Fast E data on Channel 9 only. b) Tape recorder on.
21:01:23	a) Tape recorder off.
21:02:26	a) Tape recorder on.
21:02:54	a) Tape recorder off.
21:04:10	a) Tape recorder on.
21:04:30	a) Tape recorder off.
21:05:34	a) Tape recorder on.
21:05:55	a) Tape recorder off.
21:06:54	a) Tape recorder on.
21:07:17	a) Tape recorder off.
21:37:34	a) Tape recorder on.
21:37:59	a) Tape recorder off.
21:39:38	a) Tape recorder on.
21:39:59	a) Tape recorder off.
21:40:46	a) Tape recorder on.
21:41:24	a) Tape recorder off.
21:43:12	a) Tape recorder on.
21:43:36	a) Tape recorder off.

3. Notes

a) This is a continuation of Tape #3.

b) Sample interval is .1 μsec.

c) Time code is correct for this day.

d) The time code generator did not switch to 20:00:00 hrs. Instead it switched to 00:00:00. However, the minutes and seconds are correct.

e) Installed Slow E antenna.

2. 22 July 1978 Data Log

Tape #3

Time (Zulu)	Observations
20:55:20	a) Input level on Biomation is .1 Volt. b) Sample interval on Biomation is .05 μsec.
20:55:35	a) Tape recorder on.
20:59:08	a) Tape recorder off. b) There is a data gap.
20:59:46	a) Tape recorder on.
21:00:01	b) Tape recorder off.
21:00:49	a) Tape recorder on.
21:01:23	a) Tape recorder off.
21:09:24	a) Input level on Biomation is .1 Volt. b) Sample interval on Biomation is .05 μsec.
21:10:02	a) Tape recorder on. a) Tape recorder off.
21:10:38	a) Tape recorder on.
21:11:10	b) Tape recorder off.
21:13:35	a) Tape recorder on. b) There is 0 dB attenuation in all receivers.
21:14:05	a) Tape recorder off.
21:14:51	a) Tape recorder on.
21:15:21	a) Tape recorder off.
21:19:38	a) Tape recorder on.
21:20:02	a) Tape recorder off.
21:22:07	a) Tape recorder on.
21:22:29	a) Tape recorder off.

2. 22 July 1978 Data Log

Tape #3

Time (Zulu)	Observations
21:25:16	a) Tape recorder on.
21:25:44	a) Tape recorder off.
21:27:02	a) Tape recorder on.
21:27:26	a) Tape recorder off.
21:29:13	a) Tape recorder was left on.
21:29:35	b) Tape recorder off.
21:32:56	a) Tape recorder on.
21:33:21	a) Tape recorder off.
21:35:15	a) Tape recorder on.
21:35:38	a) Tape recorder off.
21:36:34	a) Tape recorder on.
21:36:58	a) Tape recorder off.
21:38:14	a) Tape recorder on.
21:39:14	a) Tape recorder off.
21:41:28	a) Tape recorder on.
21:41:49	a) Tape recorder off.
21:46:49	a) Tape recorder on.
21:47:03	a) Tape recorder off.

3. Notes

a) This is a continuation of Tape #3

2. 24 July 1978 Data Log

Tape #3

Time (Zulu)	Observations
17:08:51	a) Input level on Biomation is .2 Volts. b) Sample interval on Biomation is .05 μsec. c) Tape recorder on. d) These lightning signals are close.
17:09:15	a) Tape recorder off.
17:10:42	a) Tape recorder on.
17:11:14	a) Tape recorder off.
17:14:45	a) Tape recorder on.
17:15:15	a) Tape recorder off.
17:16:00	a) Tape recorder on.
17:16:27	a) Tape recorder off.
17:22:50	a) Tape recorder on.
17:23:10	a) Tape recorder off.
17:24:40	a) Tape recorder on.
17:25:10	a) Tape recorder off.
17:26:15	a) Tape recorder on.
17:26:50	a) Tape recorder off.
17:30:01	a) Tape recorder on.
17:30:35	a) Tape recorder off.
17:31:17	a) Tape recorder on.
17:31:47	a) Tape recorder off.
17:32:40	a) Tape recorder on.
17:33:01	a) Tape recorder off.
17:35:25	a) Tape recorder on.

Time (Zulu)	Observations
17:35:57	a) Tape recorder off.
17:37:32	a) Tape recorder on.
17:37:57	a) Tape recorder off.
17:39:08	a) Tape recorder on.
17:39:34	a) Tape recorder off.
17:40:54	a) Tape recorder on.
17:41:22	a) Tape recorder off.
17:43:02	a) Tape recorder on.
17:43:30	a) Tape recorder off.
17:45:52	a) Tape recorder on.
17:46:22	a) Tape recorder off.
17:48:23	a) Tape recorder on. b) 20 dB in the V 139 receiver.
17:48:54	a) Tape recorder off.
17:51:37	a) 10 dB out of V-139 receiver.
17:52:57	a) Tape recorder on.
17:53:19	a) Tape recorder off.

3. Notes

a) This is a continuation of Tape #3.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

DATA LOG

24 July 1978

TAPE NUMBER: 4

TAPE SPEED: 15

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 205:18:00:48

Stop 206:22:00:40

OBSERVERS: B. J. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: *

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	0
30	0
V-139	10
V-74 (WJ)	50
V-295	0
H-295	0

*Value not logged.

2. 24 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
18:06:48	a) Tape recorder on.
18:07:08	a) Tape recorder off.
18:07:17	a) V 74 MHz has 50 dB.
18:08:57	a) Tape recorder on.
18:09:18	a) Tape recorder off.
18:12:43	a) Tape recorder on.
18:12:58	a) Tape recorder off.
18:14:36	a) Tape recorder on.
18:14:57	a) Tape recorder off.
18:16:38	a) Tape recorder on.
18:16:59	a) Tape recorder off.
18:19:20	a) Tape recorder on.
18:19:21	a) Tape recorder off.
18:24:29	a) Tape recorder on.
18:24:53	a) Tape recorder off.
18:27:08	a) Tape recorder on.
18:27:37	a) Tape recorder off.
18:28:57	a) Tape recorder on.
18:29:25	a) Tape recorder off.
18:32:34	a) Tape recorder on.
18:32:59	a) Tape recorder off.
18:34:35	a) Tape recorder on.
18:35:02	a) Tape recorder off.

2. 24 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
18:36:51	a) Tape recorder on.
	b) Sample interval on Biomation is .05 μsec.
	c) Input level on Biomation is .2 Volts.
18:37:17	a) Tape recorder off.
18:38:50	a) Tape recorder on.
18:39:20	a) Tape recorder off.
18:42:15	a) Tape recorder on.
18:42:45	a) Tape recorder off.
18:44:50	a) Tape recorder on.
18:45:18	a) Tape recorder off.
18:47:10	a) Event.
18:47:34	a) Tape recorder off.
18:48:46	a) Event.
18:49:18	a) Tape recorder off.
18:51:04	a) Event.
18:51:30	a) Tape recorder off.
18:54:50	a) Event.
18:55:20	a) Tape recorder off.

3. Notes

a) This is a continuation of Tape #4.

b) No data on Channel 2.

c) All data collected on 24 July is located within a few km of the test site.

d) 18:47:10, we changed the data log to record the time in which an Event occurred instead of recording the time the recorder was turned on.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
17:25:43	a) Connected Channel 2 to 30 MHz log.
17:28:17	a) Event.
17:29:40	a) Tape recorder off.
17:35:35	a) Event.
17:36:01	a) Tape recorder off.
17:37:25	a) Event.
17:37:50	a) Tape recorder off.
17:40:20	a) Event.
17:41:03	a) Tape recorder off.
17:42:10	a) Event.
17:42:35	a) Tape recorder off.
17:45:47	a) 10 dB in 3 MHz.
17:46:32	a) Tape recorder off.
17:50:44	a) Removed 10 dB from 3 MHz receiver.
17:51:24	a) Event.
17:52:12	a) Tape recorder off.
7:54:25	a) Event.
:55:04	a) Tape recorder off.
56:42	a) Event.
57:18	a) Tape recorder off.
8:52	a) Event.
):34	a) Tape recorder off.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
18:02:16	a) Event.
18:02:54	a) Tape recorder off.
18:04:36	a) Event.
18:05:13	a) Tape recorder off.
18:06:10	a) Event.
18:06:40	a) Tape recorder off.
18:08:12	a) Event.
18:08:48	a) Tape recorder off.
18:10:24	a) Event.
18:11:00	a) Tape recorder off.
18:12:12	a) Event.
18:12:46	a) Tape recorder off.
18:13:30	a) Event.
18:14:06	a) Tape recorder off.
18:15:20	a) Event.
18:15:50	a) Tape recorder off.
18:17:12	a) Event.
18:17:50	a) Tape recorder off.
18:18:18	a) Event.
18:18:56	a) Tape recorder off.
18:19:50	a) Event.
18:20:27	a) Tape recorder off.
18:22:00	a) Event.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
18:22:40	a) Tape recorder off.
18:24:22	a) Event.
18:24:57	a) Tape recorder off.
18:26:00	a) Event.
18:26:36	a) Tape recorder off.
18:27:20	a) Event.
18:27:57	a) Tape recorder off.
18:29:10	a) Event.
18:29:46	a) Tape recorder off.
18:31:27	a) Event.
18:32:01	a) Tape recorder off.
18:33:18	a) Event.
18:34:05	a) Tape recorder off.
18:38:28	a) Event.
18:36:10	a) Tape recorder off.
18:38:05	a) Event.
18:38:39	a) Tape recorder off.
18:39:40	a) Event.
18:40:08	a) Recorder off.
18:41:12	a) Event.
18:41:57	a) Tape recorder off.
18:43:42	a) Event.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
18:44:17	a) Tape recorder off.
18:45:24	a) Event.
18:46:01	a) Tape recorder off.
18:47:36	a) Event.
18:48:17	a) Tape recorder off.
18:49:25	a) Event.
18:50:02	a) Tape recorder off.
18:51:00	a) Event.
	b) Approx. 2 minutes of tape without data.
18:51:30	a) Tape recorder off.
18:52:12	a) Event.
18:53:24	a) Tape recorder off.
18:55:40	a) Event.
18:56:26	a) Tape recorder off.
18:57:40	a) Event.
18:58:10	a) Tape recorder off.
18:59:06	a) Event.
18:59:48	a) Tape recorder off.
19:01:30	a) Event.
19:01:50	a) Tape recorder off.
19:02:02	a) Event.
19:02:45	a) Tape recorder off.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
19:05:02	a) Event.
19:05:30	a) Tape recorder off.
19:10:10	a) Event.
19:10:46	a) Tape recorder off.
19:16:10	a) Event.
19:16:50	a) Tape recorder off.
19:58:07	a) Event.
19:58:40	a) Tape recorder off.
20:00:27	a) Event.
20:01:02	a) Tape recorder off.
20:03:15	a) Event.
20:03:38	a) Tape recorder off.
20:04:30	a) Event.
20:05:10	a) Tape recorder off.
20:08:40	a) Event.
20:09:10	a) Tape recorder off.
20:10:40	a) Event.
20:11:14	a) Tape recorder off.
20:12:20	a) Event.
20:12:46	a) Tape recorder off.
20:16:37	a) Event.
20:17:46	a) Tape recorder off.
20:21:40	a) 74 MHz, Lin with 70 dB attenuation to Krider's van.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
20:23:30	a) Event.
20:24:02	a) Tape recorder off.
20:25:17	a) Increased 74 MHz, Lin by 10 dB for a total of 80 dB.
20:25:57	a) Event.
20:26:30	a) Tape recorder off.
20:27:45	a) Decreased 74 MHz, Lin by 10 dB for a total of 70 dB.
20:30:06	a) Increased 74 MHz, Lin by 10 dB for a total of 80 dB.
	b) Event.
20:30:55	a) Tape recorder off.
20:41:46	a) Decreased 74 MHz, Lin by 10 dB for a total of 70 dB attenuation.
21:01:50	a) V-139 MHz, Lin with 0 dB attenuation to Krider's van.
21:20:15	a) 3 MHz, Lin with 20 dB attenuation to Krider's van.
21:22:00	a) Event.
21:22:27	a) Tape recorder off.
21:24:05	a) Event.
21:24:30	a) Tape recorder off.
21:27:25	a) Event.
21:27:49	a) Tape recorder off.
21:28:50	a) Event.
21:29:25	a) Tape recorder off.
21:30:03	a) Event.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
21:31:09	a) Tape recorder off.
21:32:47	a) Event.
21:33:10	a) Tape recorder off.
21:35:06	a) Event.
21:35:40	a) Tape recorder off.
21:37:10	a) Krider through filming 3 MHz, Lin.
21:39:39	a) Event.
21:40:20	a) Tape recorder off.
21:41:50	a) Event.
21:42:30	a) Tape recorder off.
21:44:23	a) Event.
21:44:50	a) Tape recorder off.
21:47:46	a) Event.
21:48:08	a) Tape recorder off.
21:48:20	a) Event.
21:51:50	a) Tape recorder off.
21:54:19	a) Event.
21:54:50	a) Tape recorder off.
21:55:37	a) Event.
21:56:01	a) Tape recorder off.
21:57:00	a) Event.
21:57:35	a) Tape recorder off.

2. 25 July 1978 Data Log

Tape #4

Time (Zulu)	Observations
22:00:02	a) Event.
22:00:40	a) Tape recorder off.
	b) No system calibration.

3. Notes

a) Connected Channel 2 to GIT 3 MHz, Log.

b) This is a continuation of Tape #4.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

DATA LOG

26 July 1978

TAPE NUMBER: 5

TAPE SPEED: 15

TEST LOCATION: Camera Site UCS-12

ZULU TIME: Start 207:19:18:36

Stop 208:18:14:18

OBSERVERS: B. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 3

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	0
30	0
V 139	10
V 74 (WJ)	30
V 295	0
H 295	0

2. 26 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
19:18:36	a) Event.
	b) 3 MHz, Triger.
19:18:55	a) Tape recorder off.
19:27:15	a) Lightning counter removed.
	b) Time code signal straight to tape recorder.
19:27:34	a) Event.
19:27:58	b) Tape recorder off.
19:31:20	a) Event.
	b) This is a subsequent stroke.
19:31:52	a) Tape recorder off.
19:33:15	a) Event.
19:33:45	b) Tape recorder off.
19:34:46	a) Event.
19:35:28	b) Tape recorder off.
19:38:09	a) Event.
19:38:44	b) Tape recorder off.
19:40:00	a) Event.
19:40:36	b) Tape recorder off.
19:42:50	a) Event.
19:43:25	b) Tape recorder off.
19:44:45	a) Event.
19:45:15	a) Tape recorder off.

2. 26 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
19:46:26	a) Event.
19:46:48	a) Tape recorder off.
19:47:52	a) Event.
19:48:20	a) Tape recorder off.
19:51:52	a) Event.
19:52:51	a) Tape recorder off
19:54:30	a) Event.
19:55:08	a) Tape recorder off.
19:57:19	a) Event.
19:57:59	a) Tape recorder off.
19:58:48	a) Event.
19:59:20	a) Tape recorder off.
20:00:00	a) Event.
20:00:47	a) Tape recorder off.
20:05:20	a) Event.
20:05:48	a) Tape recorder off.
20:09:00	a) Event.
20:09:37	a) Tape recorder off.
20:11:46	a) Event.
20:12:26	a) Tape recorder off.
20:16:49	a) Event.
20:17:20	a) Tape recorder off.

2. 26 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
20:19:20	a) Event.
20:19:40	a) Tape recorder off.
20:21:47	a) Event.
20:22:30	a) Tape recorder off.
21:23:44	a) Event.
21:24:11	a) Tape recorder off.
21:28:52	a) Event.
21:29:30	a) Tape recorder off.
21:30:46	a) Event.
21:31:05	a) Tape recorder off.
21:32:22	a) Event.
21:32:58	a) Tape recorder off.
21:33:30	a) Event.
21:33:58	a) Tape recorder off.
21:36:14	a) Event.
21:36:58	a) Tape recorder off.
21:38:02	a) Event.
21:38:36	a) Tape recorder off.
21:40:48	a) Event.
21:41:22	a) Tape repcrder off.
21:42:17	a) Event.
21:42:50	a) Tape recorder off.
21:43:33	a) Event.

2. 26 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
21:44:10	a) Tape recorder off.
21:46:04	a) Event.
21:47:30	a) Tape recorder off.
21:47:32	a) Event.
21:48:10	a) Tape recorder off.
21:48:40	a) Event.
21:49:10	a) Tape recorder off.
21:51:49	a) Event.
21:52:30	a) Tape recorder off.
21:54:16	a) Event.
21:54:50	a) Tape recorder off.
21:55:40	a) Event.
21:56:20	a) Tape recorder off.
21:57:40	a) Event.
21:58:20	a) Tape recorder off.
21:59:51	a) Event.
22:00:15	a) Tape recorder off.
22:01:25	a) Event.
22:01:56	a) Tape recorder off.
22:02:35	a) Event.
22:02:59	a) Tape recorder off.
22:04:40	a) Event.
22:05:20	a) Tape recorder off.
22:06:12	a) Event.

2. 26 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
22:06:36	a) Tape recorder off.
22:08:00	a) Event.
22:08:26	a) Tape recorder off.

2. 27 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
14:15:00	a) Event.
14:15:25	a) Tape recorder off.
14:18:20	a) Event.
14:18:45	a) Tape recorder off.
14:21:40	a) Event.
14:22:10	a) Tape recorder off.
14:23:58	a) Event.
14:24:25	a) Tape recorder off.
14:26:30	a) Event.
14:27:18	a) Tape recorder off.
14:29:40	a) Event.
14:30:29	a) Tape recorder off.
:34:18	a) Input level on Biomation changed to .05 Volts.
	b) Sample interval on Biomation changed to .1 μsec.
14:35:20	a) Tape recorder off.
14:36:30	a) Event.
14:38:20	a) Tape recorder off.
14:38:33	a) Event.
14:40:52	a) Tape recorder off.
14:42:50	a) Event.
14:43:40	a) Tape recorder off.

2. 27 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
14:44:50	a) Event.
14:45:32	a) Tape recorder off.
14:47:22	a) Event.
14:48:10	a) Tape recorder off.
14:49:20	a) Event.
14:50:22	a) Tape recorder off.
14:51:47	a) Event.
14:52:20	a) Tape recorder off.
14:53:40	a) Event.
14:54:25	a) Tape recorder off.
14:56:57	a) Input level on Biomation changed to .1 Volt. b) Sample interval on Biomation changed to .1 μsec. c) Event.
14:57:25	a) Tape recorder off.
15:00:00	a) Event.
15:00:28	a) Tape recorder level.
15:02:30	a) Event.
15:02:58	a) Tape recorder off.
15:04:49	a) Event.
15:05:20	a) Tape recorder off.
15:07:52	a) Event.
15:08:35	a) Tape recorder off.

2. 27 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
15:09:39	a) Event.
15:10:25	a) Tape recorder off.
15:10:45	a) Event.
15:11:20	a) Tape recorder off.
15:12:50	a) Event.
15:13:20	a) Tape recorder off.
15:14:44	a) Event.
15:15:28	a) Tape recorder off.
15:17:00	a) Event.
15:18:06	a) Tape recorder off.
15:19:23	a) Event.
15:20:50	a) Tape recorder off.
15:22:22	a) Input level on Biomation is .1 Volt. b) Sample interval on Biomation changed to .05 μsec. c) Event.
15:23:10	a) Tape recorder off.
15:25:00	a) Event.
15:25:40	a) Tape recorder off.
15:28:23	a) Event.
15:28:50	a) Tape recorder off.
15:30:24	a) Event.
15:30:56	a) Tape recorder off.

2. 27 July 1978 Data Log

Tape #5

Time (Zulu)	Observations
17:46:17	a) This is a large system to the south.
	b) Event.
17:46:58	a) Tape recorder off.
17:48:35	a) Event.
17:49:10	a) Tape recorder off.
17:50:57	a) These signals are from a close storm system.
	b) Event.
17:51:30	a) Tape recorder off.
17:52:32	a) Event.
17:53:20	a) Tape recorder off.
17:57:00	a) Event.
17:57:40	a) Tape recorder off.
17:59:43	a) Event.
18:01:20	a) Tape recorder off.
18:03:30	a) Event.
18:04:05	a) Tape recorder off.
18:12:38	a) Event.
	b) Recorder on, letting tape run out.
	c) Event.
18:14:18	b) End of tape.

KENNEDY SPACE CENTER THUNDERSTORM EXPERIMENT

DATA LOG

27 July 78

TAPE NUMBER: 6

TAPE SPEED: 15

TEST LOCATION: USC-12

ZULU TIME: Start 208:18:31:03

Stop 208:20:52:20

OBSERVERS: B. Wilson

1. EQUIPMENT SETTINGS (Initial)

1.1 Electric Field Antenna Gain

Slow: 1

Fast: 4

1.2 Receiver Attenuators

Receiver Frequency (MHz)	Attenuation (dB)
3	*
30	*
V 74 (WJ)	*
V 139	*
V 295	*
H 295	*

*Values not logged.

2. 27 July 1978 Data Log

Tape #6

Time (Zulu)	Observations
18:21:03	a) Event.
18:21:48	a) Tape recorder off.
18:24:02	a) Event.
18:24:28	a) Tape recorder off.
18:27:59	a) Event.
18:28:30	a) Tape recorder off.
18:28:10	a) Event.
18:28:40	a) Tape recorder off.
18:30:00	a) Event.
18:30:32	a) Tape recorder off.
18:32:44	a) Event.
18:33:15	a) Tape recorder off.
18:35:00	a) Event.
18:35:55	a) Tape recorder off.
18:38:07	a) Event.
18:40:41	a) Tape recorder left on for about 3 minutes.
18:42:20	a) Tape recorder off.
18:44:12	a) Event.
18:44:50	a) Tape recorder off.
18:46:10	a) Event.
18:46:52	a) Tape recorder off.

2. 27 July 1978 Data Log

Tape #6

Time (Zulu)	Observations
18:49:20	a) Input level on Biomation is .2 Volts.
	b) Sample interval on Biomation is .05 μsec.
	c) Event.
18:49:50	a) Tape recorder off.
18:51:45	a) Event.
18:52:20	a) Tape recorder off.
18:54:00	a) Event.
	b) 3 MHz antenna broke during wind and rain storm.
18:54:55	a) Tape recorder off.
19:35:48	a) Event.
	b) Tape recorder servo system oscillating.
19:36:20	a) Tape recorder off.
19:38:13	a) Input level on Biomation is .1 Volt.
	b) Sample interval on Biomation is .05 μsec.
	c) Event.
19:38:52	a) Tape recorder off.
19:41:11	a) Event.
19:41:32	a) Tape recorder off.
19:42:45	a) Event.
19:43:12	a) Tape recorder off.
19:44:10	a) Tape recorder servo system oscillating.
19:44:59	a) Tape recorder off.

2. 27 July 1978 Data Log

Tape #6

Time (Zulu)	Observations
19:46:30	a) Event.
19:47:05	a) Tape recorder off.
19:47:47	a) Event.
19:48:15	a) Tape recorder off.
19:49:12	a) Tape recorder servo system oscillating.
	b) Event.
19:49:45	a) Tape recorder off.
19:52:20	a) Event.
19:52:55	a) Tape recorder off.
20:11:00	a) Event.
20:11:40	a) Tape recorder off.
20:27:05	a) Event.
20:27:30	a) Tape recorder off.
20:51:44	a) Event.
20:52:20	a) Tape recorder off.